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Edited by

LEWIS STEPHEN PILCHER, M.D., LL.D.

of New York

With the Collaboration of

SIR WILLIAM MACEWEN, M.D., LL.D.   **W. H. CLAYTON GREENE, F.R.C.S**
of Glasgow   of London

LYMPHANGIOMA OF THE NECK

By James E. Thompson, F.R.C.S., Eng. F.A.C.S.

AND

V. H. Keiller, M.D.

of Galveston, Texas

Lymphangioma of the neck is so rare a disease, that few surgeons have an opportunity to study directly more than a very small number of cases. Aside from the rarity of the condition, it presents peculiar pathological and anatomical features which are not yet fully understood, so that full report of all such tumors appears to be advisable. It is our privilege to be allowed to present a careful histological study of two cases of widely different clinical types which have been recently under our care in the John Sealy Hospital.

The neck is so well supplied with lymphatics that we should expect to find in this region true benign neoplasms composed of lymph-filled, endothelial-lined channels, which may or may not communicate with the normal regional lymphatics. These tumors possess the power of independent growth, and this growth occurs in the endothelial layer. Cell proliferation is slow. Nevertheless there may be a rapid filling of the channels with fluid, causing cystic dilatation, and thus giving a false impression of rapid enlargement of the tumor. Cell division is usually typical. Sometimes the mitoses become abnormal in frequency or configuration, and the suspicion of a malignant change (to endothelioma) is justified. As in many other benign tumors, such malignant changes may occur, either as a result of inflammation or traumatism, or without known cause.

Pathologically, lymphangiomata fall into three general types, the simple or capillary, cavernous and cystic. With the simple variety we are not especially concerned. In the neck, as elsewhere, they are small in size and superficial in position, so that their diagnosis and removal is a matter of little difficulty. The typical cavernous tumor may occur in the subcutaneous tissue or under the deep fascia. It consists of large anastomosing channels which may contain in their midst irregular masses of lymphocytes, aberrant lymph follicles and nodes, and quite frequently, many neoplastic blood-vessels which give it the appearance of a mixed hæmangio-lymphangioma. When such a tumor is situated deep in the neck it may cause serious errors in diagnosis and give rise to extreme difficulties during removal. The solid

tissue of the lymph-nodes may be grossly unrecognizable as such, and may arouse the suspicion of malignant disease, and the numerous blood-vessels may cause the operation to be protracted and bloody.

The cystic form of tumor is of even greater interest. It is still not properly understood, although the amount of attention recently given to it has
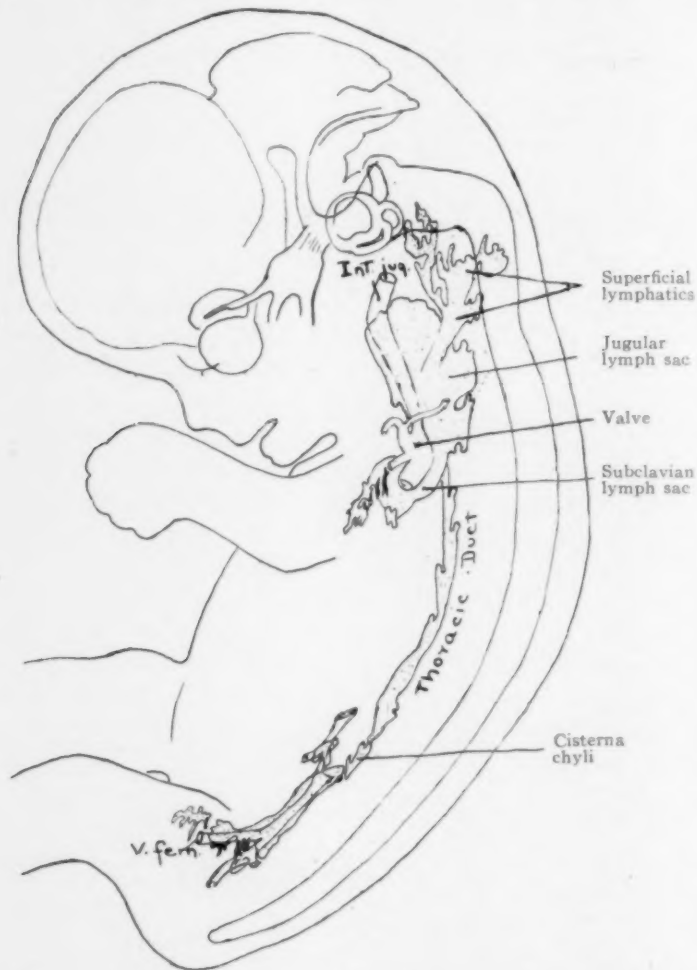
FIG. 1.—Diagram of jugular and subclavian sacs in 30 mm. human embryo. (After Sabin.)

cleared up many of the problems connected with it. In the neck frequently, in the axilla occasionally, more rarely in the groin, and in the retroperitoneal space, large cystic tumors are met with which may be unilocular or multilocular, which are filled with lymph and lined by endothelium. In many cases the collection of fluid occurs with surprising rapidity, so that one suspects an infective condition, yet the walls and the fluid contents of the tumor show no signs of inflammation. Again, having attained a certain size, the cyst may as suddenly cease to enlarge and remain for years at a standstill.

There is every reason to suppose that these hygromata are at the outset cavernous lymphangiomata, which become dilated with lymph either as a result of a change in the drainage, or an alteration in the function of their lining membrane. The sudden onset and rapidity of their growth is difficult to understand. It has been suggested that it indicates very active cell production, with an invasive power on the part of the endothelium; and the extension of these tumors into the axilla and mediastinum has been thought to corroborate this view. Against this there is very definite negative evidence,
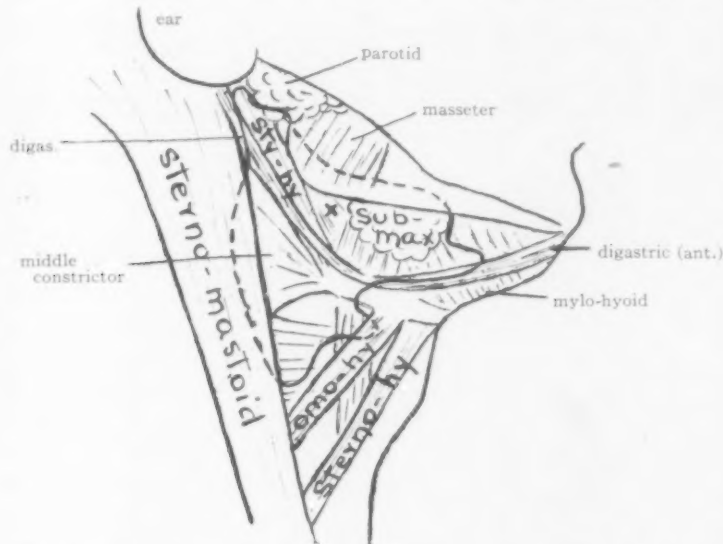
Fig. 2.—Case I. Anatomic relations of hæmangio-lymphangioma. At x the tumor was in contact with the superior constrictor of the pharynx.

in that the microscope shows the walls to be made up of small inactive lymphatics with adventitious fatty and fibrous tissue, and the lining endothelium of the cyst itself contains but few cells in the process of division. There is no active cell growth in a tissue which microscopically shows resting cells; and we cannot properly speak of any fluid collection as possessing the property of active growth no matter how rapidly it may enlarge. The " deep invasive power " is much better explained by the embryological origin of these tumors and the " rapid enlargement " on an hypothesis of altered cell function permitting increased lymph to collect.

Physiologists are still disinclined to accept a secretory function for endothelial cells, yet most pathologists and histologists incline to Heidenhain's contention that the lymph is in part a secretion, and not merely the result of osmosis and filtration. Few clinicians recalling the enormous amount of fluid in joint, pleural and peritoneal cavities (all endothelial lined) in infective or tumor conditions, will doubt that under pathological stimulation at any rate, endothelium does exercise a secretory function. That which lines the lymph-vessels does not usually secrete to such an extent that it attracts attention; the secretion, if it be such, is ordinarily diffused at once into the tissue

spaces and appears as tissue œdema. Yet endothelium of lymphatic vessels may, under certain physiological conditions, lose its permeability and prevent diffusion. The mesenteric lymphatics retain within their walls, under conditions of health, the chyle which they have taken up from the intestine. Pathologically, this endothelial impermeability may be greatly increased as in the infective conditions of serous cavities already mentioned. In order to explain the cyst formation in lymphangioma one must imagine an altered function with either increased production of fluid or decreased permeability of the walls, or both, since mere occlusion of the lymph passages draining the tumor would give rise to tissue œdema as well as to cyst formation, and this we do not find to be usually the case.

With reference to the invasive properties, the tendency of tumor growth is along the line of least resistance and an actively proliferating tumor in the neck should tend to grow outward and forward. This is precisely the direction taken by the cystic hygroma when it enlarges. It does not grow into the axilla or mediastinum. When it is found to extend from the root of the neck into these regions, it has actually originated in this situation, but has lain quiescent until cyst formation caused it to present as a visible swelling. This raises certain questions regarding the congenital origin of lymphangioma. Almost always where the history is clearly given, one finds that the tumor appeared at birth or so early that a congenital origin is probable. This is true to a certain extent of all lymphangiomata, but it is almost invariably true of those situated in the neck. This feature has led many pathologists to consider that an embryonic fault is the starting point of the condition; and in the peculiarities of the anatomic relations and the morphology of those found in the neck, there is much evidence to support this belief.

The lymphatic system begins at the end of the sixth week, with the formation of capillary nets of lymphangioma-blasts. These lymphatic anlagen appear in certain definite regions or " centres of initiation " which are marked by sac-like dilatations. From these centres new channels are formed by budding and canalization. The first pair of lymph sacs is situated in the neck between the primitive jugular and the subclavian veins, corresponding in position to the cervical lymph hearts of the amphibia; a second smaller pair occurs in connection with the iliac veins. The lymphatics of the trunk arise as smaller independent spaces in the mesenchyme which later become joined into large vessels. The lymph-vessels of the head, neck and arm are in the main outgrowths from the iliac sacs; those of the lower limb, pelvis and buttock, outgrowths from the iliac sacs. Yet it must be remembered that in these regions also, numerous independent angioblastic islands arise in the mesenchyme and become attached only secondarily to the jugular sac outgrowths (Huntington). Probably all growth in the older fœtus and in the child after birth takes place as a result of the growth of already established channels. In considering tumors appearing some years after birth, one must bear in mind that the lymph-vessels are actively growing structures throughout the growth of the child, but since differentiation of endothelial cells is more

or less complete at birth, new channels probably arise only from those already laid down. In the consideration of tumors of all varieties arising in childhood, there is often too little attention given to the normal growth and continued development of cells occurring after birth. No one who has studied infant histology can feel that the end of intra-uterine life terminates cellular differentiation. It seems, therefore, to be going rather far afield to seek an origin for all lymphangiomata in " embryonic rests," even though one grasps the opportunity to explain on an embryologic basis certain peculiarities of
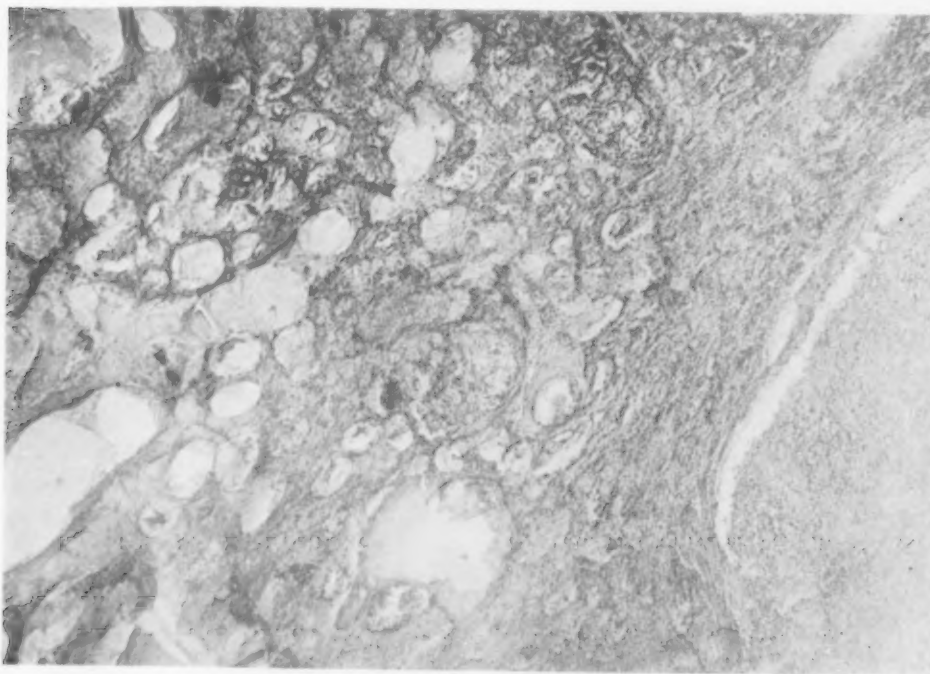
FIG. 3.—Case I. Hæmangio-lymphangioma of neck.

those most frequently met with in the cervical region. Dowd, in 1913, reporting four cases of cystic hygroma of the neck and reviewing ninety-one others, first definitely called attention to the relationship of the jugular lymph sac of certain adult fishes and of vertebrate embryos with the site, anatomic relations and cystic character of these growths. Since the publication of his article the jugular sac has been found to exist in the early human embryo, as well as in the usual " laboratory mammals," so that the embryonic origin of these tumors is established on a firm basis.

Before passing on, let us consider further the position of the jugular sac. It lies in the interval between the primitive common jugular vein and the subclavian, and early acquires an opening into both of these. Cephalad, its outgrowths extend along and lateral to the internal jugular and lie in intimate relation to the cervical nerves, as they emerge from the intervertebral foramina. Caudad, it is prolonged along the internal mammary vessels; while

laterally, it grows along the subclavian and axillary veins into the arm. In the posterior mediastinum it makes connection with the precaval lymphatics. Whether this growth is all the result of budding from the sac wall, or whether, as seems more accurately demonstrated, it is in part the result of a confluence of many independent islands, the result is, that one large lymph-space is formed, which is intimately associated with the great veins of the root of the neck and arm and lies in close relation with the cervical nerves and the prevertebral muscles. In the ordinary course of events, the sac
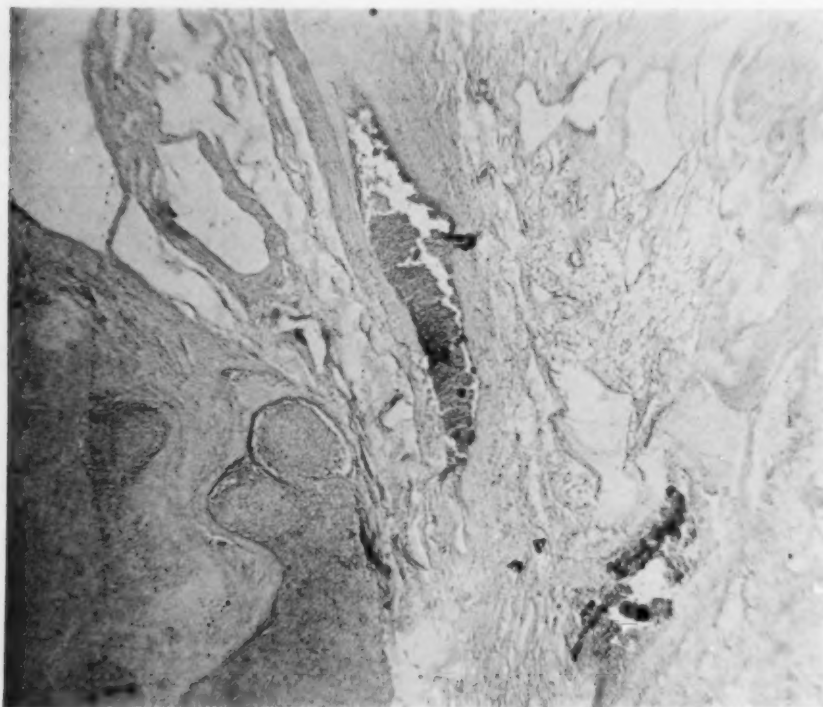
FIG. 4.—Hæmangio-lymphangioma of the neck.

becomes obliterated by the growth of reticular connective tissue and the development of lymph follicles and lymph-nodes. These arise from the endothelium lining the sac, at first lying within the lumina of the sac and its outgrowths, later becoming massed into definite organoid structures with independent vascular supply and capsule. A defect occurring at this stage would give rise to a condition of mingled lymphoid and lymphangiomatous tissue, such as is frequently found in the cavernous type of tumor. Our first case belongs to this type.

CASE I.—E. P., male, white, age thirteen months. History.—The baby is the first child of healthy parents. At birth he had a small tumor of the left side of the neck, apparently above or in line with the hyoid bone. This is said by the mother to have been the size of a hen egg, and to have moved freely under the skin. At the age of twelve days an operation was performed and the tumor

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removed. The mother says that a small drain was placed in the anterior end of the incision, and that five days or so after the operation it began to drain pus, and continued to do so for some days. Finally the wound healed, leaving a tight scar, which the mother loosened by massage.

About the time that the baby was recovering from the operation, œdema of the face and lip of the same side began to appear, and within a few weeks the tumor of the neck came back and soon reached its present dimensions. This time it was of a diffuse character, and not "loose in the neck" as before. The baby has drooled saliva a great deal since the face became so much swollen. He suffers from severe attacks of tonsillitis whenever he gets the slightest cold.

Examination.—The child is fat, but rather pale and flabby. He appears to be in fair health. He appears to suffer no pain about the face or head.

Local Examination.—The right side of the face and neck is normal. The left side presents a diffuse swelling, suggestive of œdema, of the whole side of the face from the lower eyelid down; there is a little puffiness of the left side of the nose, and much swelling of the left side of the upper lip, causing a downward drooping of the angle of the mouth. There is some puffiness of the left lower lip, and general swelling of the whole cheek, causing projection into the mouth and externally; below, this swelling blends with a tumor of the upper part of the neck, so that the line of the mandible is obliterated. The cervical swelling is diffuse in character, and extends from the median line anteriorly to the angle of the mandible posteriorly; the anterior border of the sternomastoid cannot be felt. Below, the confines of the tumor are not easily made out, but it decreases rapidly and there is practically no swelling below the level of the cricoid cartilage. Over the whole swelling there is a bluish tint to the skin, and there are a number of rather large prominent veins.

A probable diagnosis of branchiogenetic cyst was made, the œdema being attributed to chronic inflammation as a result of infection and previous partial removal. The vascularity of the surface was not easily explained on this assumption and caused considerable anxiety.

Operation.—April 18, 1921. The submaxillary region was exposed by a curved incision similar to that usually employed for ligature of the lingual artery. The separation of the skin was rendered very difficult by the presence of scar tissue from the previous operation and by the vascularity of the mass and the adherence of skin to it. This was especially true of the posterior part of the tumor. The limits of the mass were very hard to define, as it spread round the normal structures and was everywhere obscured by scar tissue and great numbers of bloodvessels; its nature also made the differentiation of tumor from normal tissue very difficult. Bleeding was not very profuse, but there was a constant oozing which was almost impossible to control and which greatly increased the difficulties of the dissection. It was soon seen that the tumor was not a branchiogenetic cyst, but was of a lymphangiomatous nature. There were no large cavities, but many small cysts containing clear fluid. The diagram (Fig. 2) shows the anatomical relationships of the tumor. It extended upwards in the direction of the styloid process. The lower pole of the parotid gland was imbedded in it, and a small portion was removed with the tumor; in this region a lymphatic gland was recognized and removed. This was the only lymph-node seen in the dissection. Lower down the tumor extended under the anterior border of the sternomastoid muscle, from which it was separated with considerable difficulty. Anteriorly it was spread over the upper border of the anterior belly of the digastric and was inseparably blended with the superficial part of the submaxillary gland, which had to be removed. The deep part of the submaxillary gland was not involved and was left undisturbed.

In the submaxillary region the tumor extended upwards under cover of the

Fig. 5.—Case II. Cystic lymphangioma of neck.

lower border of the mandible, and behind the submaxillary gland it was in contact with the superior constrictor of the pharynx. Below the hyoid bone the tumor extended to the level of the anterior belly of the omohyoid and was wrapped around its upper margin. There was no sign of extension over the mandible on to the cheek, nor did the dissection explain the œdema. The wound was closed with silkworm gut sutures, with a gutter drain at the posterior extremity.

Convalescence.—The child left the table in fairly satisfactory condition, considering the length and character of the operation. Hypodermoclysis was used at once, and the baby reacted well. On the third day there was some swelling of the neck and wet dressings were used; a considerable quantity of thin milky discharge
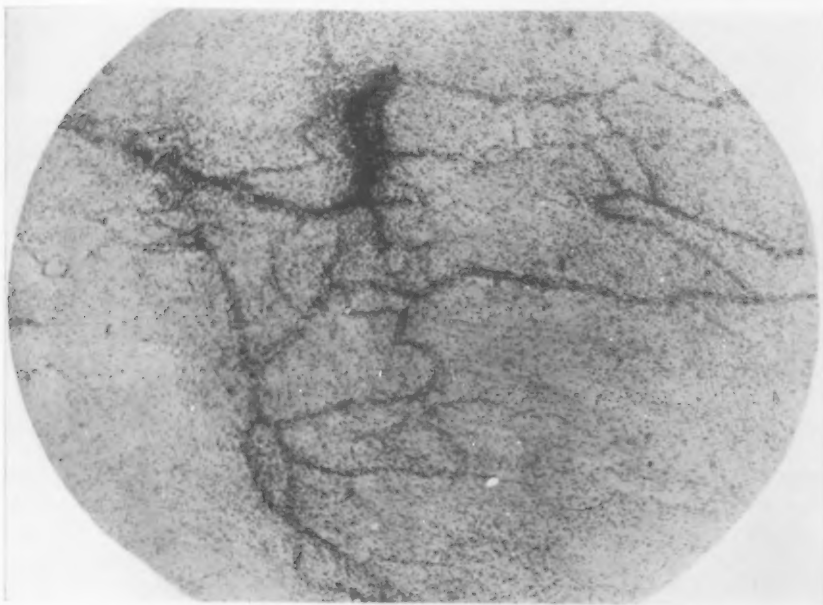
FIG. 6.—Cystic lymphangioma of the neck. Thin cyst wall mounted flat.

appeared the next day, and continued for some days after; there was slight fever for the first eight days, but this was never alarming. During the whole of the convalescence the baby drooled much saliva and it was difficult for him to swallow, on account of paralysis of the tongue from implication of the hypoglossal, which had been exposed in the dissection.

The baby was sent home on May 5th; the wound at this time was clean, and the paralysis of the tongue improving slowly. Six months later the paralysis of the tongue had disappeared; there was no recurrence in the neck, but there was still some œdema of the face and especially of the upper lip. It seems probable that there is a diffuse lymphangiomatous condition here also.

Pathological Report.—(See Figs. 3 and 4.) Grossly the tumor consists of a rather dense fibrous tissue full of small blood-vessels and small cysts varying from ½ cm. in diameter (in the preserved condition) to microscopic size. There are a few areas which appear to be embedded lymphatic glands and some of these are necrosed. Microscopically the mass consists of a few lymph follicles, more or less isolated from each other lying in a network of dilated and thickened lymph channels. There are many small blood-vessels giving parts of the tumor an appearance of hæmangioma. There is no suggestion of endothelioma nor of malignant proliferation of any kind. The portion of submaxillary gland sectioned is em-

bryonal in appearance and deficient in ducts. Pathological diagnosis: Lymphangioma, with an excess of blood-vessels.

In this case the tumor lay high in the neck, and there was no evidence that the main cavity of the jugular sac was at fault, since there was no cyst or tumor tissue below the omohyoid. Apparently the obliteration of the jugular sac had occurred in the normal manner, and the malformation occurred in its upper outgrowths. In our second case the condition is very different; the ingrowth of lymphoid tissue has not occurred; and the large potential space formed by the jugular sac, after remaining for a certain period undistended, and therefore unobserved, has suddenly dilated and become a matter of prime importance.

CASE II.—M. C., female, white, age five years. *History.*—Father died three years ago of Bright's disease. Mother living and well. One sister, aged three, in good health. The child had typhoid fever two years ago; whooping cough last spring; no sequelæ in either case.

Present Trouble.—The mother first noticed a tumor of the neck four weeks ago; since then it has grown steadily larger. One week ago the child first complained of pain and stiffness in the neck.

Examination.—The child was in excellent general health; all findings were negative except for the local lesion. The left side of the neck was occupied by a cystic swelling, covered by normal skin, which showed neither increased vascularity nor œdema. The tumor occupied the lower part of the posterior triangle and appeared to extend below the clavicle. It was very slightly tender on pressure, or when the head was moved. It was resilient, with a suggestion of fluctuation.

On admission to the hospital October 20, 1920, the temperature was 100.6°, but it dropped to normal during the night. On the following morning the cyst was aspirated and 10 c.c. of clear yellow fluid withdrawn. This confirmed the diagnosis of lymphatic cyst and operation was set for the following day. The temperature went to 100.6° again that afternoon, but there was no pain and the child did not appear to be ill.

Operation.—November 1, 1920. A transverse supraclavicular incision was made and the cyst was exposed. It was found to be multilocular. The superficial wall was very thin and in parts transparent, the deeper parts thicker. The mass extended below the clavicle into the axillary space, and lay in close contact with the upper cords of the brachial plexus. In order to facilitate the dissection about 30 c.c. of fluid were aspirated. This was clear, straw colored, and coagulated spontaneously. The dissection involved the free exposure of the internal jugular vein, the scalenus anterior, the anterior border of the trapezius muscle, and the phrenic nerve and upper cords of the brachial plexus. The wall of the cyst was applied to these structures, but did not infiltrate them. None were injured in the dissection, and it was possible to remove the entire wall of the cyst without injury to any of the surrounding nerves or vessels. A small drain was placed at the posterior end of the incision and the skin closed.

Convalescence.—The drain was removed on the second day and the stitches on the seventh day. Healing was by first intention, and the child left the hospital November 8, 1920, in excellent condition.

Pathological Report.—The specimen consists of a multilocular cyst ovoid in shape, 7 cm. by 5 cm. in diameter, having thin walls in which lie a few smaller cysts which do not communicate with the main cavity.

The fluid in the large cavity is yellow and coagulates spontaneously; that in some of the small cysts is colorless and does not coagulate even after fixation in

formalin. Microscopically the coagulum is acellular. The greater part of the cyst wall is very thin, transparent, and histologically (Fig. 6) consists of a delicate membrane of coarse and fine interlacing connective tissue, traversed by lymphatic vessels and capillary blood-vessels. The ordinary staining of this portion of the wall shows no lining endothelium, but a portion which was spread and stained with silver nitrate showed the typical pavement endothelial structure. A part of the cyst wall is thicker, about 3 mm., and sections of this show a definite endothelial lining. The wall (Fig. 7) is here composed of capillary lymphangiomatous spaces, and of spindle-shaped cells, fat and connective tissue. This region is full of capillary blood-vessels. Some of the areas here contain a few cells suggestive of
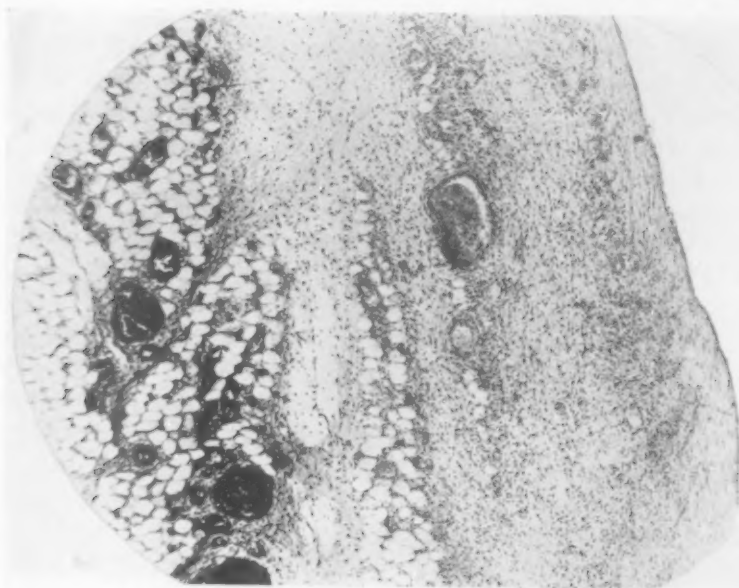
FIG. 7.—Case II. Cystic lymphangioma of neck. Section of cyst wall.

myxoma, but there is no evidence of any malignant change in any portion of the tissue.

Diagnosis.—Hygroma (multilocular lymphatic cyst) of the neck.

After History.—There has been no opportunity to examine the child recently, as she has left town. November, 1922, two years after the operation, her mother reported by letter that she was in excellent health; no sign of tumor.

This case illustrates excellently the quiescent interval and the sudden growth and cystic character of those tumors which arise as a result of the failure of obliteration of the jugular sac. The absence of lymph follicles and nodes in connection with it is further evidence that the essential fault is in the walls of the sac. So long as there was no abnormal increase of fluid within the space, no visible tumor appeared. Something, the exact nature of which we are unable to determine, possibly an infective condition or toxic absorption which was so mild that it left no positive signs of inflammation behind, caused an increased secretion of lymph and at the same time apparently a decreased drainage, and the tumor, enlarged along the lines of least resistance, showed itself as a visible swelling in the neck. In this particular case there was no

prolongation of the tumor into the axilla or mediastinum. This indicates that the axillary and thoracic embryonic outgrowths of the jugular sac had completed their development in the normal manner. In many of the cases reported, their outgrowths are still primitive and connected with the main sac; and the cystic tumor arising from them will be found to extend far down in these situations. Similarly separate axillary or mediastinal cysts may appear, with or without a cyst formed from the main jugular portion of the sac. It gives an erroneous idea of the origin and pathology of these hygromata to say that they "grow into" axilla or thorax. If this conception of their embryonic basis is correct, the anlagen from which they arise are at the start occupying these regions. Some new growth of lymphatic does occur, but it is rather the character than the amount of growth which is at fault. If the fault were merely the failure of the jugular tap to appear, then fluid should collect as soon as lymph begins to form, and tissue œdema should invariably follow. This is not the case, and it seems probable that, whatever the error in development, it is associated with an increased secretion on the part of the endothelial cells and a decreased permeability of the walls of the sac, so that escape of the excess fluid by diffusion into the surrounding tissue spaces is impossible.

Much further investigation of the absorptive properties of these cysts, and also more authoritative information regarding the physiology and pathology of lymph formation in varying conditions, are required to clear up these points. It is very necessary also that any cases of the kind, in which post-mortem examination can be made, should be most carefully dissected with a view to determining the exact condition and drainage of the regional lymphatics.

From the point of view of the surgeon, the chief matters of interest are:

1. These tumors, like most embryonal tumors, are primarily benign. Rapid growth does not indicate malignant transformation.

2. They may, and frequently do, contain a large hæmangiomatous element.

3. In all cases, and especially in the cystic forms, they are more deeply situated than a superficial inspection would lead one to suppose, and their deep relations and extensions follow certain definite lines, predetermined by their embryonic origin and not the result of infiltrative tumor growth.

4. Excision is the logical method of treatment.

BIBLIOGRAPHY

[1] Dowd, C. N.: ANNALS OF SURGERY, vol. lviii, 1913, p. 112.

[2] Downes, W. O.: ANNALS OF SURGERY, vol. lix, 1914, p. 753.

[3] Huntington, Geo. S.: Lymphatic Vessels of the Cat, Memoirs Wister Institute, Philadelphia, 1911.

[4] Keith, Herman: Embryology and Morphology.

[5] Lewis, F. T.: American Journal Anatomy, vol. ix, 1909, p. 33.

[6] Lyle: ANNALS OF SURGERY, vol. lx, 1914, p. 398.

[7] Mathews: ANNALS OF SURGERY, vol. lix, 1914, p. 753.

[8] Sabin, F. R.: American Journal Anatomy, vol. ix, 1909, p. 43.

[9] Schmieden, V.: Deuts. Zeitsch. fur Chirurgie, 1902.

[10] Winslow, R.: Surgery, Gynæcology and Obstetrics, vol. xxv, 1917, p. 428

LIGATION OF INFERIOR THYROID ARTERY

By Joseph L. DeCourcy, M.D.

of Cincinnati, Ohio

THE first indication of the reduction of thyrotoxicosis, when surgery is thought advisable, is ligation of one or both superior thyroid arteries. This together with rest for three or four months is frequently the only preparatory treatment necessary before thyroidectomy is justifiable. Occasionally, however, the improvement in these cases is not sufficient to warrant removal of the gland, and if we do so, we do it with a certain amount of risk, or attempt to reduce the risk by leaving the wound entirely open, or sometimes removing only part of the gland. This is the routine which we have used for a number of years, avoiding ligation of the inferior arteries because of an innate fear, founded upon theory, rather than clinical experience. We felt that the operation was of such a major nature that these patients could not withstand the ordeal. More recently, however, we have utilized this operation more and more with increasing gratifying results.

Ligation of all four thyroid arteries over a period of a few weeks must be condemned because of the dangers which it incurs. Theoretically, unless we have a *thyroidea ima* present we would naturally expect a gangrenous condition to follow. Tetany is also apt to occur, due to a removal of the blood supply to the parathyroid bodies. Clinically I have found a severe type of hyperthyrotoxicosis follow the fourth ligation, performed shortly after the initial ligations, although only a slight reaction followed the third ligation. Since then we have formulated the following routine:

Single or double superior ligation is performed at the first sitting—if single, the opposite side is usually ligated within the week following. The patient is then allowed to return home and is instructed to submit to almost an absolute rest. After three or four months the patient is again examined, and if thyroidectomy is still contra-indicated, in our opinion, we ligate one inferior thyroid artery. This is usually all which is necessary before performing a complete thyroidectomy. If, however, a month passes after the inferior ligation and the patient is still considered a bad risk for thyroidectomy, we then ligate the other inferior artery. This is performed from four to five months after the superior ligations and we feel that this is sufficient time for a slight collateral circulation to form about the superior poles and prevents disastrous results which may otherwise follow.

The results accruing from inferior ligation in severe cases are the following:

(1) If we consider a normal person as 100 per cent. and the improvement following a successful thyroidectomy as 90 per cent., I would say that a bilateral ligation of the superior arteries improves the patient 40 per cent., taken as an average, and ligation of all four arteries improves the patient 60

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per cent., thereby lessening the margin of danger. (The above averages were
formulated following a review of the basal metabolic rate in a post-operative
study of a large number of cases.)

(2) In thyroidectomy of the severe cases of exophthalmic type which
require ligation, hemorrhage is sometimes severe enough to narrow the safety

Fig. 1.—Position of transverse incision.

zone. With ligation of all four arteries, the hemorrhage is noticeably dimin-
ished and of little or no concern.

(3) Ligation of inferior arteries lessens more volume of blood to gland
than superior ligation.

(4) Operation of inferior ligation is not difficult and is without danger if
proper judgment is used as to time of operation.

(5) Operation can be performed in twice the time which it takes to ligate
the superior artery—frequently being performed in five minutes and can be
performed either with straight local or local combined with light nitrous
oxide anæsthesia.

(6) It is rarely, if ever, necessary to allow wound to remain open following
thyroidectomy preceded by three or four ligations.

(7) The incisions for inferior ligation can be made in same crease as
incision for thyroidectomy and only one resulting scar remains.
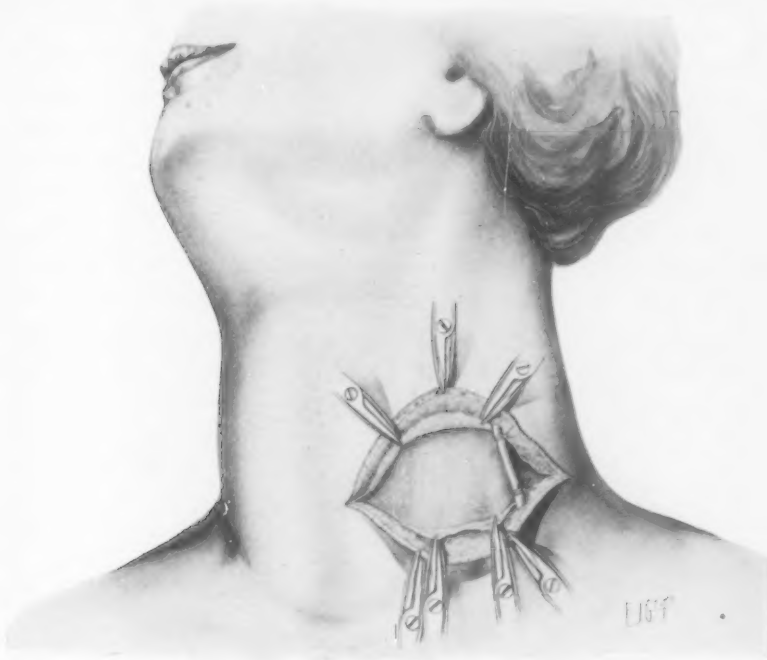
FIG. 2.—Showing division of deep fascia exposing the muscle fibres and the external jugular vein ligated.

FIG. 3.—Showing appearance of sterno-mastoid muscle, before being retracted inwardly.

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We have now performed inferior ligation sixty times with only one violent reaction, employing the following technic:

A transverse incision is made two finger breadths above the clavicle, with the centre overlying the posterior border of the sterno-cleido-mastoid muscle (Fig. 1). The incision is carried down through the deep fascia until the muscle fibres are exposed (Figs. 2 and 3). (It is sometimes necessary to ligate and divide the external jugular vein at the posterior portion of the wound.) The sterno-mastoid muscle is drawn inwardly and the division noted between the thyroid gland and the carotid sheath. A hæmostat is then placed between the thyroid gland and the carotid sheath, hugging the thyroid capsule
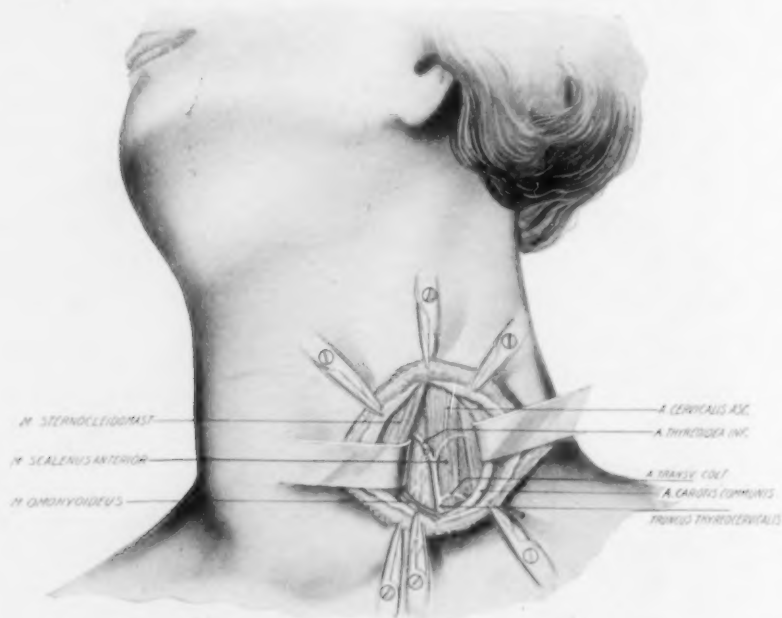
FIG. 4.—Appearance of field after dissection has been completed, showing ligature of inferior thyroid artery.

as closely as possible without opening it and the blades spread apart. The thyroid gland is then retracted inward with the sterno-mastoid muscle and the sheath of the carotid is retracted outward. The scalenus anticus muscle can be seen lying beneath covered by its fascia. The fascia is opened at the inner margin of the muscle and the inferior thyroid artery can be readily isolated (Fig. 4). It is essential that the operative field be kept absolutely dry throughout the whole procedure, because with oozing the landmarks are frequently lost and important structures may be injured.

Technical dangers which may be mentioned are, injury to the jugular vein, injury to the phrenic nerve which lies on the belly of the scalenus anticus muscle, and injury to the thyroid gland itself, thereby causing the typical reaction which occurs when thyroid tissue of this type is traumatized.

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EMPYEMA THORACIS

ANALYSIS OF TWO HUNDRED AND FIFTY CASES TREATED AT THE CHILDREN'S HOSPITAL OF PHILADELPHIA*

By HENRY P. BROWN, JR., M.D.

OF PHILADELPHIA, PA.

DURING the period from 1906 to 1922 there were 259 cases of empyema treated at the Children's Hospital and an analysis of end results with special reference to the method of treatment seemed desirable. I am indebted to Doctors Wharton, Jopson, Hutchinson, Hodge, Allen, Speese and Lee, upon whose services the cases were admitted, for the privilege of reporting them in this paper.

It is a well-known fact that empyema in children differs considerably from that occurring in adults, and it is for this reason that the cases from the Children's Hospital are presented.

The treatment varied according to the views of the chief on service at the time, but up to 1917–1918 the most frequently used method was exploratory aspiration to locate the collection, general anæsthesia and rib resection, the chest being drained with a fenestrated rubber tube.

As anyone knows who has endeavored to look up hospital records of a number of years ago, when there was apparently no one whose duty it was to supervise such records, there are often omitted many facts of interest and information which are essential for any review purposes. The Children's Hospital was not an exception in this, and in compiling this record of empyema cases, I have classified as " unknown " under the various subheadings when the fact in question is not definitely stated, even though it may be assumed that routine measures were followed.

As can be seen from a study of the " unknown " tables, this element does not alter the results very much one way or the other, but I have used it in order to make them as accurate as possible.

One of the most interesting questions in operating upon empyema cases in children, and one which has caused some discussion in Philadelphia, is rib resection *vs.* intercostal incision. Those in favor of incision claim that it can be done more readily than resection; it renders the child less subject to shock; it is not followed by rib necrosis; it is a shorter operation, and if the wound is kept open properly and the incision large enough, the drainage is just as satisfactory as when resection is done.

The resection adherents claim that it takes but very little more time to do a resection; it can be done with the same type of anæsthetic as the incision; it is not more shocking to the child; it allows of much better drainage.

At the present time the advocates of each method are about equally divided. Up to 1915 our records show that most of the surgeons did a resection, using a general anæsthetic, usually ether.

The term "cured" is a variable factor, some of the hospital internes writing up the records regarding a case as cured when the chest wound had entirely closed and remained so for several days. Others regarded a case as cured when the child was discharged with a small sinus that was draining, but without a drainage tube in it.

There were a few cases which demonstrated that occasionally each of these standards was at fault, but most of those discharged as cured evidently remained as such, for those of this type coming in for reoperation were quite rare. Of course, they may have gone to other hospitals for a secondary operation, but judging from the small number of cases operated upon elsewhere and later falling into our hands, there were not many who did not return to us when they had further trouble.

No attempt was made to follow up the cases and have them return for examination at the time this report was being prepared. In a city the size of Philadelphia with a large percentage of foreign population among the poorer classes, we have found that the people change their addresses quite frequently, often without leaving word as to their destination. Another factor is the failure to have the name properly spelled, sometimes our fault and sometimes theirs. The chief reason, however, is the fact that at the present time our Social Service Department is not large enough to enable its workers to search over the city for these cases.

The dispensary records show that most of the cases leaving the hospital as cured, with a small sinus, returned there until the sinus had closed entirely.

In view of the above facts there are classified as cured those cases discharged as cured when they left the hospital, and those discharged as improved are placed under improved, in studying the results for both resection and incision.

Studying the cases more carefully, there were 171 resections, 54 incisions, 2 aspirations, and in 34 the type of operation was not mentioned in the history, although most of the latter were done at the time when resection was the routine procedure. They are, however, classified separately for the reason stated above.

Beck's paste No. 1 was used in one case. This was a little fellow of seven who had had a resection in July, 1909, at which time a piece of his sixth rib was removed. A month later it was necessary to resect a portion of his seventh. He was discharged in September with a small sinus. In November of the same year he was readmitted and portions of the seventh, eighth and ninth were removed, exposing two pockets of pus. He was again discharged in January, 1910, with a sinus. In March he returned, the sinus still being open, and in April he was given three injections of Beck's paste No. 1 at four-day intervals. His chest closed and he-

left the hospital in two weeks apparently cured, and we have not heard from him since.

Aspiration without subsequent thoracotomy was done twice. In one instance a little girl had a pyemia with abscesses of the elbow, hand and face. She developed signs of fluid in her chest and about 400 c.c. of bloody pus was aspirated. Her chest was not opened and she was later discharged in good condition only to return in two months with an osteomyelitis of one of her metacarpals.

The other was an infant of one and five-tenths years. Two c.c. of pus were removed with an exploring needle, the smear showing a pneumococcus. In three days another exploration gave a dry tap and the child was discharged eighteen days later in good condition, the chest having cleared.

Of the 171 resections, 70, or 40.8 per cent., were cured, 61, or 35.6 per cent., were improved, 3, or 1.7 per cent., unimproved, and 37, or 21.5 per cent., died. If we regard all of the cases as being either cured, unimproved or dead, the percentage of cures would be 76.0 per cent.

Of the 54 incisions, 9, or 16.6 per cent., were cured, 20, or 37 per cent., improved, 1, or 1.8 per cent., not improved, in 2, or 3.7 per cent., the condition at discharge was not stated, and there were 22, or 40.3 per cent., of deaths. Combining improved and cured as was done above, the cured would be 53 per cent.

TABLE I.

No. operated.	Cured	Per cent.	Improved	Per cent.	Not improved	Per cent.	Result not stated	Per cent.	Deaths	Per cent.	Days per case
Resections....171	70	40.8	61	35.6	3	1.7			37	21.5	37
Incisions 54	9	16.6	20	37.0	1	1.8	2	3.7	22	40.3	35
Not stated.... 34	16	47.0	6	17.3	1	2.9	3	8.8	8	24.2	42
Totals........259	95	36.6	87	33.5	5	1.9	5	1.9	67	26.2	38

In only two of the fatal incision cases was the note made that the child was too sick for resection and an incision was therefore made. Each of these children died within twenty-four hours after operation. The exponents of incision sometimes claim that included in their mortality lists are cases too sick to resect, but our records of over 250 cases show that these two were the only ones of this type that are mentioned. It therefore seems that the mortality in each class is fairly representative.

There were 34 cases in which it was not stated what type of operation was done. Of these, 16, or 47.0 per cent., were cured, 6, or 17.3 per cent., improved. Combining these as was done above, it gives 64.7 per cent. cured. One, or 2.9 per cent., was not improved, in 3, or 8.8 per cent., the result is not stated, and there were 8, or 24.2 per cent., of deaths. These figures agree more closely with those of the resections, and there is no doubt, in view of the fact that most of them occurred before 1915 when practically all of the operations were resections, that they belong to this class. They are, however,

classed as " not stated " because of the desire to have the figures as accurate as possible.

The average number of days in the hospital per case was thirty-seven for resection and thirty-five for incision.

Pneumonia, Post-operative.—There were eight cases of post-operative pneumonia, of which six died and two recovered. Five of the fatalities had been resected and one had had an incision (this case died eighty-eight days after operation, the pneumonia obviously not being related to the type of

TABLE II.

		Died	Recovered
Post-operative pneumonia following	General	4	I
	Local	2	
	(one 88 days)		
	Not mentioned		I

Post-operative pneumonia in 4.7 per cent. of cases given general anæsthetic. Mortality of 3.8 per cent.

Post-operative pneumonia in 4.0 per cent. of cases given local anæsthetic. Mortality of 4.0 per cent.

(excluding one case 88 days after operation.)

operation, but it is nevertheless included in this group). One of the resections and one of the incisions recovered from the attack. Post-operative pneumonia thus occurred eight times in 259 operations, or 3.0 per cent., while the mortality from this cause was 2.3 per cent. All of these cases followed the primary operation, there being no record of it having followed a secondary operation. Table II shows the relationship between the type of anæsthetic and the number of cases of post-operative pneumonia.

TABLE III.

121 cases received general anæsthetic and recovered.
 25 cases received general anæsthetic and died (17.1%)

146

30 cases received local anæsthetic and recovered.
12 cases received local anæsthetic and died (28.5%)

42

47 cases anæsthetic not stated recovered.
24 cases anæsthetic not stated died (33.7%)

71

Type of Anæsthesia.—A general anæsthetic was administered to 146 patients, of which number twenty-five died, a mortality of 20.1 per cent. Forty-two were done under local anæsthesia with twelve deaths, a mortality of 40.0 per cent. In seventy-one cases the type of anæsthesia was not stated and there were twenty-four deaths, a mortality of 51.0 per cent.

As mentioned in discussing resection, most of the cases in which the type of anæsthesia was not mentioned were done during the period when ether was the method of choice. This would raise the percentage mortality slightly in the general anæsthetic class.

Reoperations.—The cases returning for reoperation are of interest and are shown in Table IV. They have been classified as: 1. Necrotic rib. 2. Discharging sinus (which includes insufficient drainage and failure of obliteration of the cavity), and one case in which the cause is not mentioned.

Of the 171 cases in which the primary operation was a resection, 7, or 4.0 per cent., returned for necrotic rib, 10, or 5.8 per cent., for discharging sinus, which with the one the cause of which was not given, gives a total of eighteen cases and a percentage of 10.5 requiring reoperation.

Of the fifty-four incisions, nine returned for reoperation, a percentage of 16.6. Here again resection seems to give a better result than incision.

TABLE IV.
Reoperations

Resections		Incisions
(1) Necrotic rib............ 7	4.0% of total resections	
(2) Discharging sinus (insufficient drainage)... 10	5.8% of total resections	9
(3) Not mentioned......... 1	0.7% of total resections	
Condition following secondary operations:		
Cured................ 7		⎰ 1 following resection ⎱ 1 following incision
Improved............. 11		6
Not improved.........		1
Number of secondary operations:		
One reoperation....... 16		6
Two reoperations 1		1
Three reoperations 1		1
Four reoperations....... 0		1
Intercostal incisions followed by ⎰ Incision 3 ⎱ Resection 6		

Per cent. of resections needing secondary operation: 171 resections. 18 reoperations. 10.5 per cent.

Per cent of incisions needing secondary operations: 54 incisions. 9 reoperations. 16.6 per cent.

Classified according to the number of secondary operations, of the resections, sixteen were reoperated upon once, one twice and one was reoperated upon three times.

In the nine incisions, six were reoperated once, one twice, one three times and one child, at present in the hospital, was reoperated upon four times. The original operation on this last child was an incision, and it has been followed by four rib resections, the last one having been done according to the method advocated by Colonel Keller of the Walter Reed Hospital.

In three of the cases in which the primary operation was an incision, the secondary was also an incision. In six, the original being an incision, a secondary resection was done.

Regarding the results of reoperation, seven of the resections are classified as cured and eleven improved. For the reason mentioned elsewhere in discussing cured and improved, it seems fair to classify these eighteen cases as being cured, for as far as our records go, none of them have died from

their empyema and none of them are at present under treatment at the hospital.

Of the incisions, two were cured, six improved (a total of eight cured) and the case still in the hospital after having had four reoperations is classified as unimproved, but is still under treatment.

Age.—Table V shows that, according to our records, the greatest number of cases occur in the second year, under the figure 1 in the table. The mortality at this age was twenty-eight of sixty-five cases, 43.0 per cent. In the first year it was 40.7 per cent. in twenty-two cases. As the age increased the mortality tends to decrease, this being in accord with most observers.

Complications.—As complications in fatal cases, gangrene of the lung occurred once; post-operative pneumonia eight times, as mentioned else-

TABLE V.
Mortality by years

Age	No. of cases	Deaths	Percentage of deaths
0	22	9	40.7
1	65	28	43.0
2	55	12	21.8
3	29	11	37.9
4	33	4	12.1
5	24	2	8.3
6	17	1	5.8
7	8	2	25.0
8	6	0	0
9	4	1	25.0
10	3	1	33.3
11	1	0	0

where; bronchial fistula with lung abscess twice; bronchial fistula once; tuberculous peritonitis once; empyema of the opposite side once; embolus once; lung abscess once; undetermined rash twice.

Of the cases that recovered, undetermined rash occurred once; diphtheria six times; measles three times; scarlet fever six; chicken-pox two; otitis media once and one case had an abdominal infection.

Dakin Solution.—Dakin solution was used in fourteen of the cases, obviously too small a number to warrant drawing any conclusions of value. It was not administered in a uniform manner in each case, some receiving second-hour instillations while others were merely irrigated with it at the time of dressing, depending more or less on how well the child stood the treatment. Under this procedure, necessarily far from perfect, the duration of the empyema was not markedly shortened, varying from twenty-one to eighty days with an average of 49.9. It was usually started on the third or fourth day after operation. A study of the cases gives the impression that the Dakin solution, *per se*, has not been of much benefit in the comparatively few cases in which it has been tried. This conclusion is of course open to the criticism that the technic was at fault. In several of the cases, when the profuse purulent discharge had diminished, a 2 or 5

per cent. solution of dichloramine-T was used with apparently good results. In only two instances was the notation made that the children did not stand the irrigation well and in no case did a bronchial fistula follow its use. At least one of our surgeons is convinced that its action is deleterious in young children.

Recently a few of the closed types of operation have been done, an attempt being made to make an air-tight closure between tube and chest wall, the free end of the tube being conducted beneath a solution in a bottle at the side of the bed. By means of a Y glass connection the pleural cavity can

TABLE VI.
Complications

	Fatal		Recovered
	Resect.	Incision	
Gangrene of lung	I		
Pneumonia of opposite side	6	I	I
Bronchial fistula—lung abscess	I	I	
Bronchial fistula			I
Tuberculous peritonitis	I		
Empyema opposite side	I		
Embolus?		I	
Lung abscess		I	
Gangrene of lung		I	
Undetermined rash	I	I	I
Diphtheria			6
Measles			3
Empyema following appendectomy			I
Otitis media			I
Scarlet fever			4
Chicken pox			2

be irrigated as often as desired. This was usually maintained for four or five days and then simple direct drainage instituted.

If aspiration is done until adhesions form, as indicated by the fluid becoming frankly purulent, and then a thoracotomy done, the records show that in children simple direct drainage by means of a rubber tube gives as good results as any of the other methods tried. In no case was mention made of mediastinal fluttering or other evidence of cardiac embarrassment due to the direct opening of the chest.

The pneumococcus and staphylococcus were the organisms most frequently found on culture.

In conclusion, from a study of the above cases, it would seem that the best results were obtained by exploratory aspiration with removal of enough of the pleural exudate to relieve symptoms from pressure, until adhesions had formed. This can be determined by the fluid becoming frankly purulent, except sometimes in the case of streptococcus. Drainage is then instituted by rib resection, using either local or general anæsthesia (nitrous oxide-oxygen) according to the preference of the operator, a simple fenestrated rubber drainage tube being inserted. If Dakin solution is used it

should be so administered that the fluid comes into contact with all parts of the empyema cavity. This can be accomplished by having the child lie in such a position during the irrigation that the sinus opening is at the highest level, the cavity then being filled till it overflows.

In a small series of cases in another hospital I have started the irrigation within four or five hours after operation, and have not as yet encountered any deleterious effects that could be ascribed to its use. In most instances where it was used the duration of the use of the drainage tube was considerably shortened.

Sometimes in a large cavity if it be entirely filled as mentioned, the weight of the solution will exert undue pressure on the mediastinum, causing dyspnœa, etc. If the solution is carefully introduced, its administration can be stopped before this stage is reached.

As the discharge diminishes and becomes glairy, the irrigations are stopped, the tube shortened and 2 to 5 per cent. dichloramine-T substituted for the Dakin. The tube should not be kept in too long a time, it usually being removed when the discharge has lost its purulent character (5 to 15 organisms per field) and is considerably diminished in amount. At the time of dressing each day for three or four days after the removal of the tube, a small catheter is introduced into the sinus in order to relieve any collection that may have formed. A few c.c. of dichloramine-T may be injected before removing the catheter.

If the temperature does not rise for four or five days after removal of the tube, the chest will usually close satisfactorily. No attempt to make a secondary closure of the chest after sterilization should be done.

If the child is old enough, lung exercises such as blowing water from one bottle to another will help in reëxpanding the lung.

THE EXPERIMENTAL PRODUCTION OF PEPTIC ULCER*

By Frank C. Mann, M.D.

AND

Carl S. Williamson, M.D.

Rochester, Minn.

DIVISION OF EXPERIMENTAL SURGERY AND PATHOLOGY, THE MAYO FOUNDATION

THE most important and almost the only uncontradicted fact with regard to peptic ulcer is its anatomic and physiologic location. These absolutely typical ulcers occur only in that portion of the gastro-intestinal tract which can be exposed to the action of a mineral acid. Whatever may be the cause or causes of such ulcers, and however important or unimportant the relation of acid to their production, it would seem to be of the greatest significance that they occur chiefly in the portion of the gastro-intestinal tract which, although secreting an alkaline secretion, may have an acid secretion poured over it. This is true not only of gastric and duodenal ulcers, but also of gastrojejunal ulcer, a rarer form of peptic ulcer. Such ulcers follow gastro-enterostomy and are located at a point where they may be subjected to an acid medium.

Acute gastric or duodenal ulcers may be produced experimentally with relative ease, and the methods employed to produce them successfully are numerous.[†] Few of these methods can have any significance with regard to the cause of the ulcer in man. Rosenow's method is an exception; he produces ulcer by the administration of specific bacteria. It should be noted that these acute ulcers are produced experimentally by any method only in the proportion of the gastrointestinal tract in which there may be acid.

Very little success has been attained in the experimental production of the typical chronic or subacute peptic ulcer as it occurs in man. The acute ulcer which can be produced so readily and by so many methods, either heals spontaneously, or its occurrence is associated with and probably secondary to a condition resulting in death.

Many attempts have been made to evaluate acid as a primary or secondary factor in the cause of peptic ulcer. The results of such attempts have led to diametrically opposite conclusions. Certain observers believe the acid to be directly responsible for the ulcer, while others believe that there is no causal relationship. Of those holding the former view, some believe that the ulcer develops in association with an overproduction of acid, or an increase in the degree of acidity, and others, that it develops when there is a decrease in the amount or degree of acidity. Neither of these viewpoints have been proved, but there is evidence to substantiate both.

Numerous experimental investigations have been made to determine the relation of acid to ulcer. The most direct attempts have included the administration of acid or alkali, with or without operative procedures. It is very difficult to administer a substance so as to simulate the normal elaboration and secretion of that substance. Thus acid by mouth cannot be given over periods long or constant enough to make its effect quite comparable to that secreted by the gastric glands. The results of such experiments, therefore, have been more or less negative.
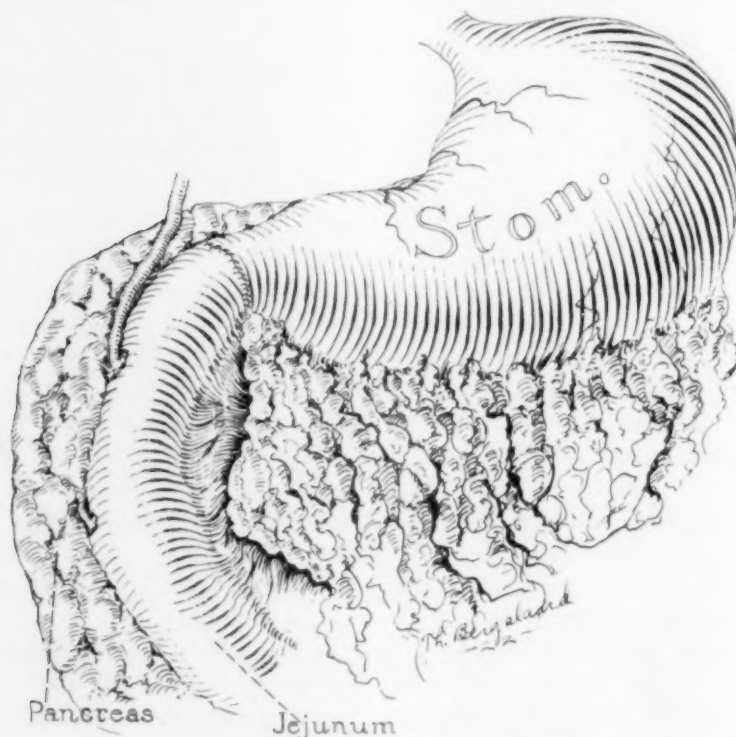

FIG. 1.—Diagram illustrating the operative procedure in the first series of experiments in which the duodenum was removed. Continuity of the gastro-intestinal tract was maintained by anastomosis of jejunum to the stomach. The bile and pancreatic ducts were transplanted into the former.

The degree of acidity and the amount of acid to which the ulcer-bearing area of the gastro-intestinal tract is subjected depends not only on an acid producing mechanism, but on an alkaline producing mechanism. The acid secreted by the gastric mucosa must be neutralized before the action of the pancreatic enzymes can be effective. The neutralization not effected by the food must be effected by this alkaline mechanism, which consists of three secretions, the intestinal secretion (also that of the pyloric mucosa[6]), the pancreatic juice, and the bile. Enough alkali must be produced by these combined secretions to neutralize the acid that passes the pylorus if digestion in the intestine is to be carried out normally. The upper portion of the intestinal tract can be subjected to an acid medium just

as effectively by damaging the alkaline mechanism as by the administration of acid, thus avoiding the difficulties of such administration. It is our purpose here briefly to review the results of some of the experiments conducted for the purpose of injuring or destroying the alkaline mechanism.

Methods of Experimentation.—The experiments were conducted on dogs, in whom spontaneous ulcer is rare.[7, 8, 12] The operations were performed under ether anæsthesia, and with sterile technic. Since the purpose of the experiment was to injure one of the major factors of digestion, one of our technical
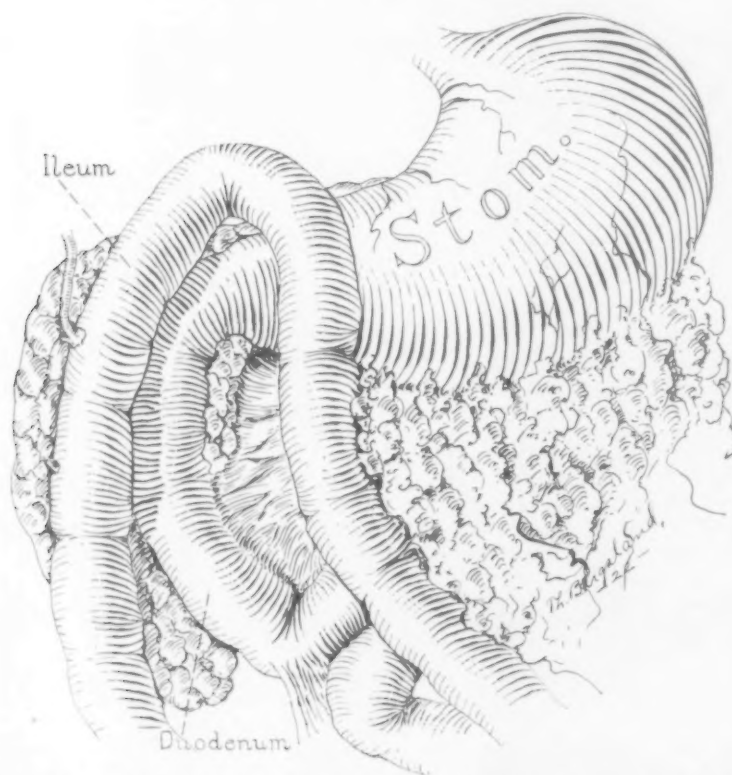
Fig. 2.—Diagram illustrating the operative procedure in the second series of experiments in which the bile and pancreatic ducts were isolated, sectioned and transplanted into a loop of ileum.

problems was dietetic. The animals were fed with great care, nevertheless the maintenance of their physical condition was only partially successful. Four series of experiments were performed. In the first series the duodenum was removed, thus eliminating the portion of the intestine which had most to do with producing the necessary alkali to neutralize the acid. In the second series the pancreatic and bile ducts were transplanted to the terminal ileum, thus eliminating the value of these secretions in neutralizing the gastric juice. In the third series the duodenum was removed and the pancreatic and bile ducts transplanted to the terminal ileum. In the last series the duodenum was

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functionally resected and made to drain its own secretion and that of the pancreas and liver into the lower portion of the ileum.

Results of Experiments, the Development of Ulcer Following Duodenectomy.—Of the first series of experiments, the removal of the duodenum, the operative technic and general results will not be reviewed, since they have been reported in connection with other experiments;[9, 10] the results pertaining to the development of ulcer only will be discussed. It should be understood that the duodenum was completely removed; the first portion of the jejunum was anastomosed to the stomach and made to occupy the position held by the duo-

FIG. 3.—Diagram illustrating the operative procedure in the third series of experiments in which the duodenum was removed and the bile and pancreatic ducts were transplanted into a loop of ileum. The procedure thus consisted of a combination of those employed in the first and second series.

denum, and the common bile duct and pancreatic duct were transplanted into it at about the same distance from the stomach as they were originally (Fig. 1). After we had perfected the technic, the removal of the duodenum was accomplished very successfully. The animals remained in good condition for long periods, one dog was in excellent condition four years after duodenectomy. The post-operative course in ten of the dogs was followed for periods varying from three hundred twenty-five to five hundred fifty-six days. Two of these animals coming to necropsy, three hundred ninety-three and five hundred fifteen days, respectively, after operation, had typical chronic peptic ulcers.

The Development of Ulcer Following the Transplantation of the Bile and

Pancreatic Ducts to the Terminal Ileum.—In a second series of experiments the secretions of the liver and pancreas were made to drain into the terminal ileum. The object of these experiments was to remove from the duodenum whatever of value the secretions might possess in neutralizing the gastric juice. The operative technic consisted in isolating and sectioning the bile and pancreatic ducts and transplanting them into the ileum, 30 to 50 cm. from its termination (Fig. 2). The method of transplanting the ducts has been described.[9, 10] The animals recovered from the operation and, with careful
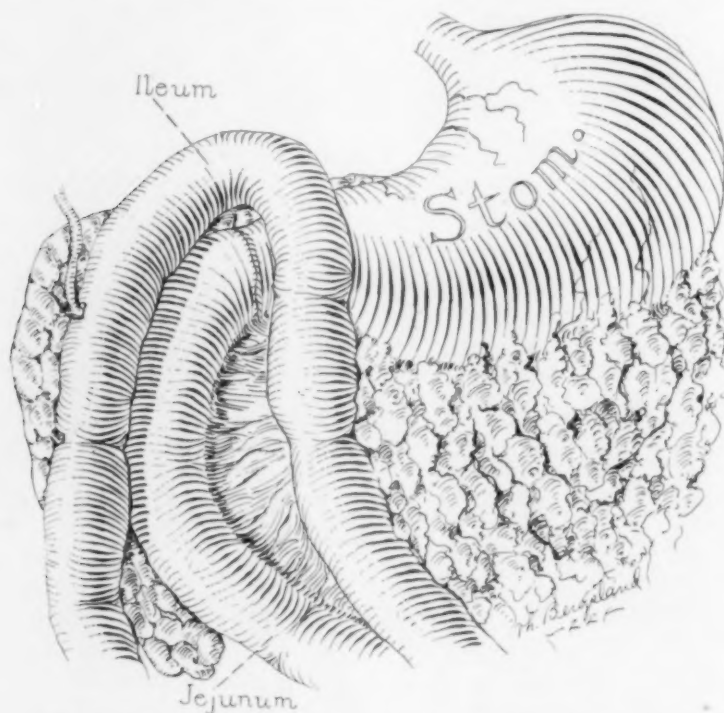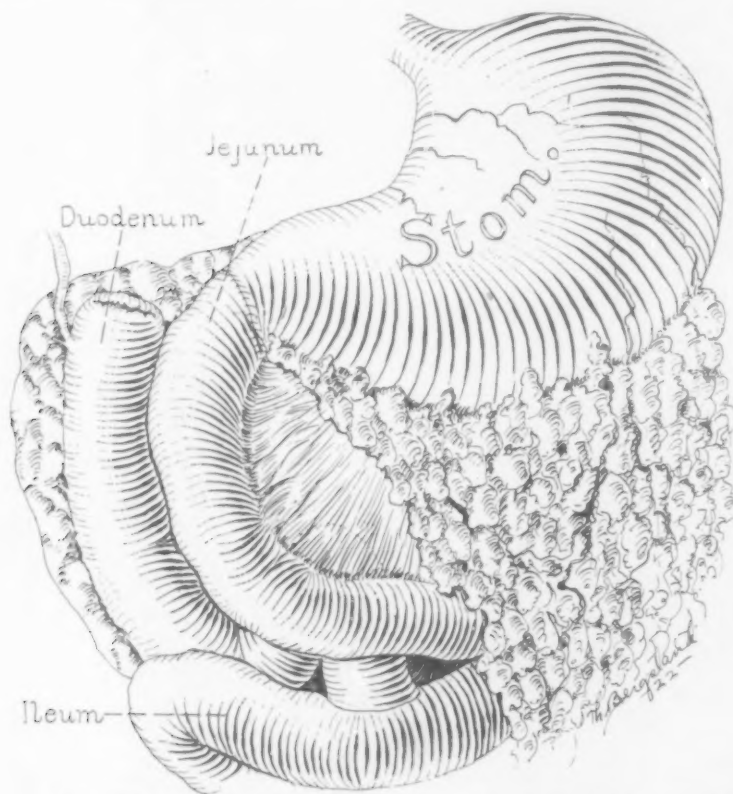

Fig. 4.—Diagram illustrating the operative procedure in the fourth series of experiments in which the duodenal, liver, and pancreatic secretions were made to drain into a loop of ileum.

feeding, in some instances remained in good condition. However, in most cases there was a variable loss of weight. In thirty-one experiments in this series in which the animal lived eight days or longer, definite ulcer developed in ten; five of the ulcers were of the characteristic subacute or chronic type.

The Development of Ulcer Following Duodenectomy and Transplantation of the Bile and Pancreatic Ducts to the Terminal Ileum.—The partial success in producing ulcer by the procedures employed in the first and second series of experiments led us to conduct another series in which these procedures were combined. The duodenum was removed as in the first series, and the jejunum made to occupy the position formerly occupied by the duodenum. The bile and

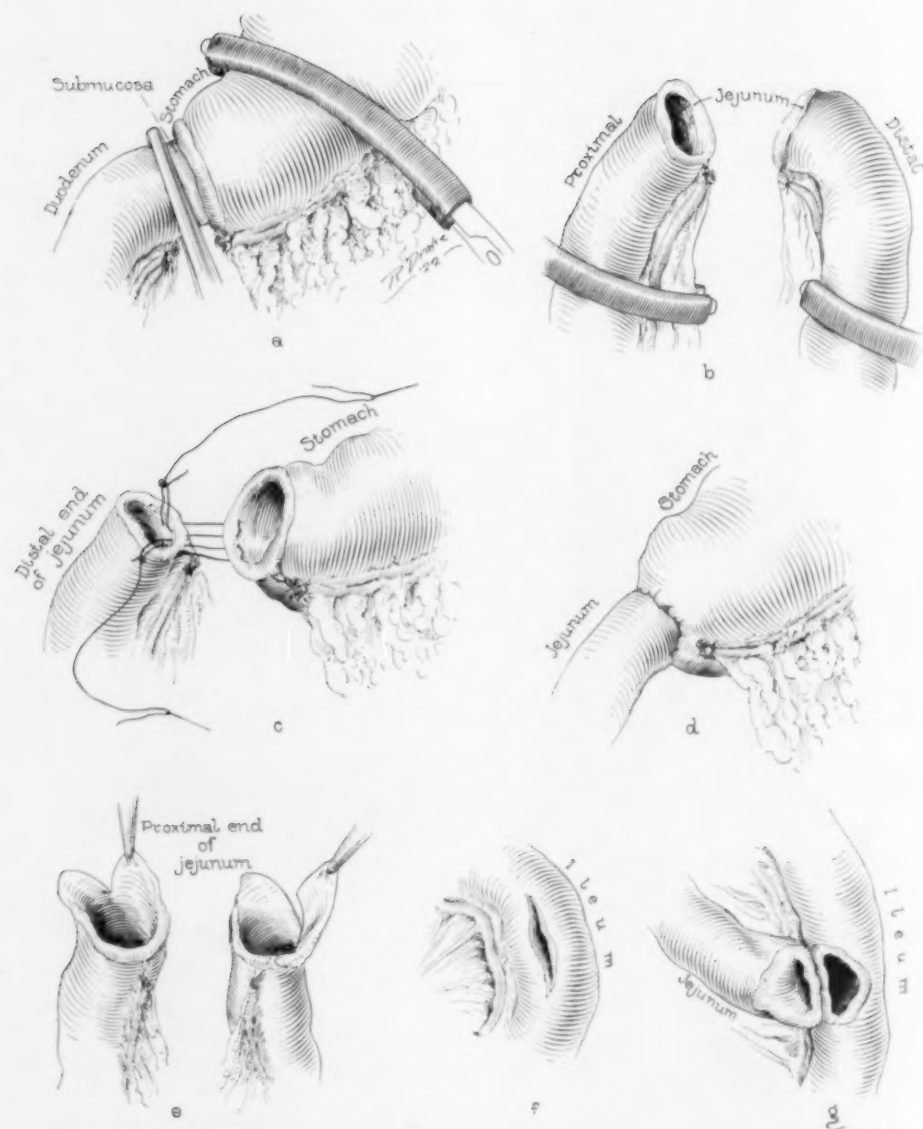FIG. 5.—A series of drawings illustrating the operative procedures in the fourth series of experiments. In (a) the pylorus is isolated and incised down to the mucosa; in (b) the first portion of the jejunum is isolated and sectioned; in (c) and (d) the distal end of the jejunum is anastomosed to the stomach; in (e), (f), and (g) the proximal end of the jejunum is anastomosed to the ileum.

pancreatic ducts, however, were not transplanted into the jejunum but into the terminal ileum. This removed all three of the neutralizing secretions from the point of emergence of the gastric juice from the stomach into the intestine (Fig. 3).

The removal of the duodenum and the transplantation of the ducts into the ileum were accomplished with comparative ease, but the combination of the two procedures resulted in a high mortality. The entire gastro-intestinal contents were involved in the operation and the ducts were transplanted in a region where bacteria abound. Most of the animals could not be kept in good
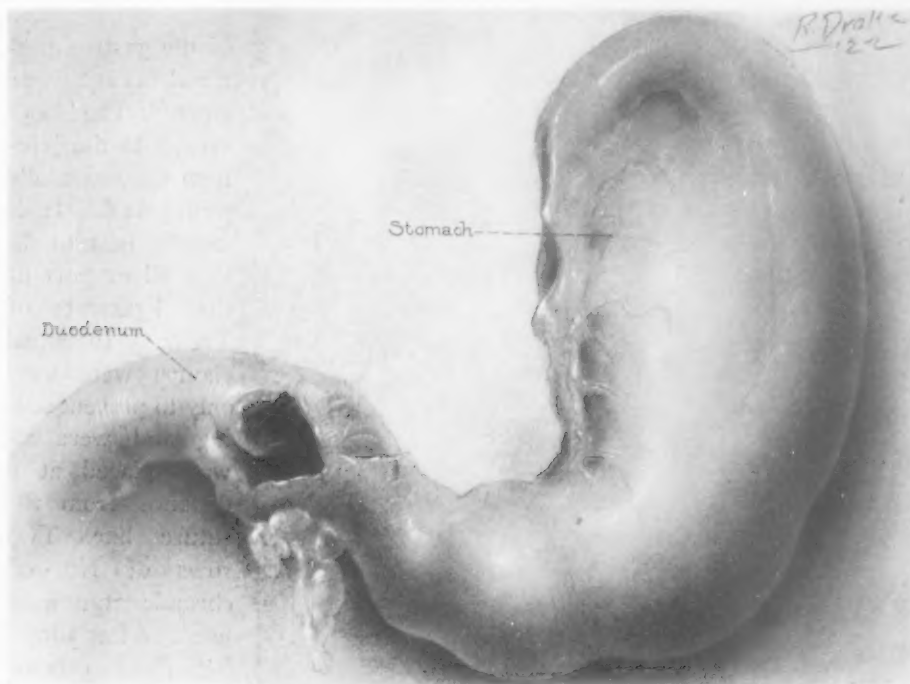
FIG. 6.—A subacute ulcer of the duodenum which produced death by perforation fifty-seven days after transplantation of the bile and pancreatic ducts to a loop of the ileum (F. 700).

physical condition following the procedure. However, of ten animals coming to necropsy within twelve to one hundred twenty-four days after operation, eight showed ulcer; seven of the ulcers were of the subacute or chronic type.

The Development of Ulcer After Functional Resection of the Duodenum. —Although well developed chronic ulcer was found in a high percentage of the animals operated on in the third series of experiments, the operative mortality was necessarily high. In order to simplify the procedure and to make it possible to keep the animals in better condition, a fourth series of experiments was performed in which the duodenum was made to drain its own secretion and that of the liver and pancreas into the intestine at a considerable distance from the pylorus. Briefly, this procedure consisted of (1) exposure, isolation and

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section of the pylorus with inversion and closure of the duodenal end, (2) section of the first portion of the jejunum, (3) end-to-end anastomosis of the distal end of the jejunum to the stomach and (4) end-to-side anastomosis of the proximal end of the jejunum to the ileum at a variable distance (25 to 75 cm.) from the cæcum (Figs. 4 and 5).

Several important procedures were found to be advisable in order to insure the success of the operation and to remove objectionable features with regard to the development of ulcer. All three sites of operations were prepared and all incisions made down to the mucosa before the lumen of the gastro-intestinal tract was entered. The blood-vessels to the jejunum were carefully protected. It is usually best to divide all or part of the ligament of Treitz. Intestinal clamps were used only to prevent soiling and were always placed at a distance from the suture line. Two rows of No. 00 chronic catgut were used. After adopting these procedures practically all the operations were successful and the animals were kept in good or fair

Fig. 7.—Acute, multiple ulcers of the stomach and jejunum found nineteen days after draining the duodenum into the ileum. Death was due to hemorrhage from the ulcers (F. 784).

physical condition. Many thus operated on are still alive and in fair condition. Fourteen of sixteen animals coming to necropsy had ulcers, all of the subacute or chronic type.

General Effects of the Operative Procedure upon the Animal.—As we have mentioned, the operative procedure necessarily was very injurious to the digestion of food in the intestine, consequently most of the animals did not maintain their normal physical condition. In some instances, in spite of painstaking care, they steadily lost weight. However, many that had ulcer lost but little weight and in some instances practically normal nutrition was main-

tained. Rarely was there an actual increase in weight. In some animals the weight remained about the same as before operation for a considerable time, and then suddenly decreased. In all such, ulcer was found, and it seems quite possible that the sudden loss of weight followed the formation of the ulcer. This is emphasized by the fact that in a few experiments exploration was made immediately after the decrease in weight was noted and ulcer was found.

Characteristics of the Ulcers. Time of Occurrence.—All but two animals
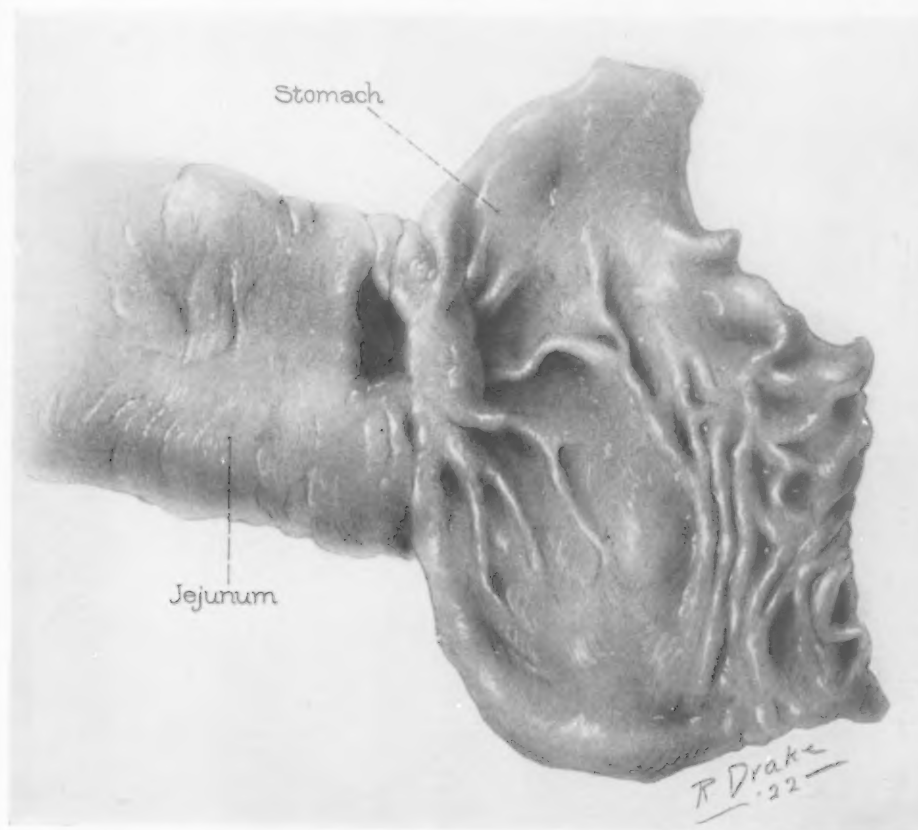
Fig. 8.—A chronic ulcer found one hundred and twenty-five days after the removal of the duodenum and transplantation of the bile and pancreatic ducts into a loop of ileum (F 609).

coming to necropsy less than two weeks after operation did not have ulcer. In two instances acute ulcers were present earlier, and one caused death by perforation. All the ulcers of the subacute or the chronic type were noted usually two or more weeks after operation; the usual time for the development of the ulcer appeared to be during the third or the fourth week after operation.

Location of the Ulcer.—The ulcer was usually located in the intestine a few millimetres distal to the pyloric mucosa. In certain instances there were multiple ulcers in the pyloric mucosa. In the experiments in which the duodenum was not disturbed (in which the ducts only were transplanted), the

27   417

FIG. 9.—A subacute ulcer which produced death by perforation fifty days after draining the duodenum into the ileum. An ulcer was suspected in this animal because of the sudden decrease in weight, and an exploratory operation was performed on the forty-sixth day after operation. The ulcer was found almost to have perforated. Omentum was sutured around the lesion in the hope of preventing perforation. This was not successful, as perforation and death occurred four days later (F 748).

FIG. 10.—A subacute ulcer obtained forty days after draining the duodenum into the ileum (F 472).

ulcer was usually anteriorly on the left side. In the experiments in which the jejunum was anastomosed to the stomach, the ulcer was usually slightly posterior and on the right side; it rarely touched the suture line.

Size and Shape of Ulcers.—Most of the ulcers were relatively large. They measured from 4 to 15 mm. in diameter. The acute types were irregular in shape, and usually longer in relation to the transverse diameter of the intestine. The chronic type usually were round or elliptical.

Number of Ulcers.—As a rule only one ulcer was present; in some instances there were two ulcers, but very rarely were they multiple.

Gross Description.—The common type of ulcer appeared, grossly, like
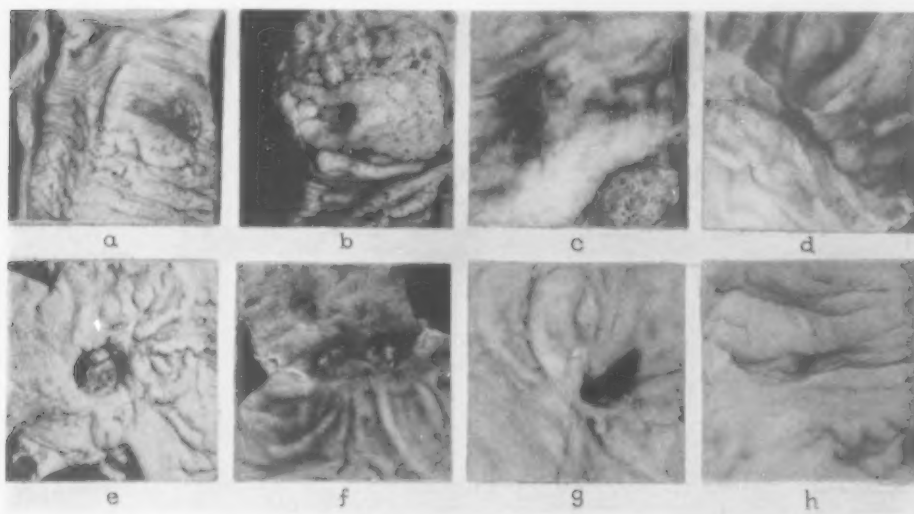
FIG. 11.—A series of acute, subacute and chronic ulcers which followed the various operative procedures described.

the peptic ulcer noted in man. It was more or less circular, punched out, and with overhanging edges. It always involved the entire thickness of the mucosa and usually penetrated considerably deeper in the intestinal wall. The base was hard to the touch, and on section was thick and œdematous. In several instances the ulcer was of the perforating type and passed completely through the intestinal wall; sometimes such perforations were closed by the adjacent coil of intestine, omentum or pancreas. In other instances leakage with peritonitis and death occurred. In one instance a fatal hemorrhage occurred from multiple ulcers.

Microscopic Description.—Microscopically the ulcers appeared to be similar to the subacute and chronic type noted in man. There was destruction of the mucosa and of the intestinal wall down to the base of the ulcer, with leukocytic infiltration and the initial proliferation of connective tissue. In many of the ulcers the base was composed entirely of connective tissue.

Discussion.—A method for the consistent production of a type of peptic

ulcer, which in all its characteristics is similar to the subacute or chronic ulcer that is found in man, was devised through this series of experiments.

We are not as yet in a position to make positive statements with regard to the development of, or the factors responsible for the production of such ulcers. It should be emphasized, however, that the success of the method of producing ulcer was due to the presumption that the acid or lack of alkali is an important etiologic factor. Whether or not this was correct, future studies must decide, but in any event our methods have been successful

FIG. 12.—Photomicrograph of a subacute ulcer obtained twenty-eight days after draining the duodenum into the ileum. At the site of the section the ulcer has not quite perforated through the muscularis. x 8 (F 780).

FIG. 13.—Photomicrograph of subacute ulcer obtained twenty-nine days after draining the duodenum into the ileum. The ulcer has perforated through the entire thickness of the jejunal wall. Note overhanging edge. x 8 (F 774).

in producing the characteristic lesion. We are conducting studies which we hope will add further data with regard to acid as a factor in the cause of ulcer, and shall continue the investigation in association with Rosenow ‡ concerning the part bacteria may play.

Summary.—Experiments were devised for diverting the secretions which neutralize the gastric juice, as it leaves the stomach, to another portion of the intestine removed from the point of emergence of the acid. Under such conditions typical subacute or chronic peptic ulcer, quite comparable pathologically to that found in man, developed in the intestinal mucosa just adjacent to the gastric mucosa in a high percentage of cases.

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‡ Stained sections of some of the ulcers were studied by Doctor Rosenow and evidence of an infective process containing a paired streptococcus was found. A culture of fresh tissue of one of the ulcers yielded a streptococcus which produced acute gastric and duodenal hemorrhages and ulcers in a high percentage of rabbits injected, and few or no lesions elsewhere.

FIG. 14.—An area through the base of the ulcer shown in Figure 13. The base of the ulcer is made up entirely of newly formed connective tissue, omentum and pancreas. (x 25.)

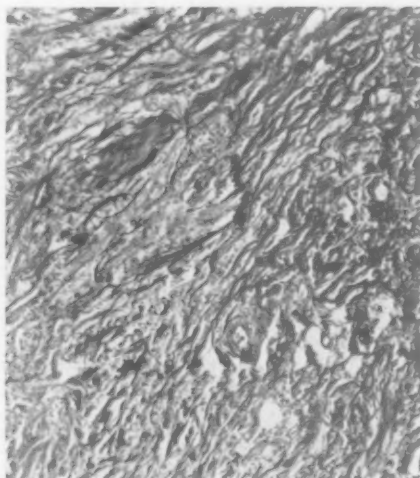FIG. 15.—A higher magnification of an area of Figure 14, showing the newly formed connective tissue. (x 100.)

FIG. 16.—Photomicrograph of chronic ulcer. This ulcer is shown grossly in Figure 8. (x 8.)
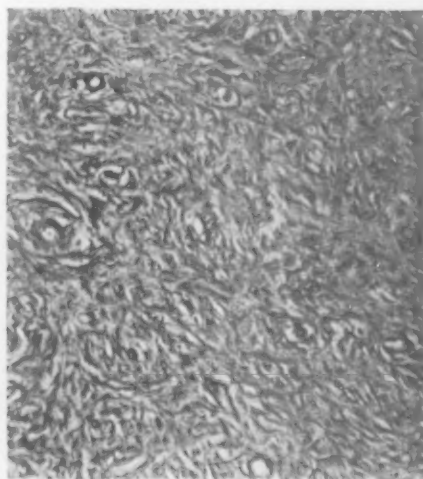
FIG. 17.—Photomicrograph of base of ulcer shown in Figures 8 and 16. The entire base of the ulcer is composed of connective tissue which has been formed for a considerable period of time. (x 100.)

BIBLIOGRAPHY

[1] Bolton, C.: Ulcer of the Stomach. London, Arnold, 1913, 396 pp.

[2] Butsch, J. L.: Ulcers of the Gastrointestinal Tract with Special Reference to Gastro-jejunal Ulcers. Papers from the Mayo Foundation and the Medical School of the University of Minnesota, 1915–1920, vol. i, pp. 57–84.

[3] Durante, L.: The Trophic Element in the Origin of Gastric Ulcer. Surg., Gynec. and Obst., 1916, vol. xxii, pp. 399–406.

[4] Greggio, E.: Des ulceres gastroduodenaux. Arch. d. méd. exper. et d'anat. path., 1916–1917, vol. xxvii, pp. 533–590.

[5] Ivy, A. C.: Studies on Gastric and Duodenal Ulcer. Jour. Am. Med. Assn., 1920, vol. lxxv, pp. 1540–1542.

[6] Ivy, A. C.: Contributions to the Physiology of the Stomach. Studies on Gastric Ulcer. Arch. Int. Med., 1920, vol. xxv, pp. 6–31.

[7] Ivy, A. C., and Oyama, Y.: Secretion of Pars Pylorica Gastri. Am. Jour. Physiol., 1921, vol. lvii, p. 51.

[8] Mann, F. C.: A Study of the Gastric Ulcers Following Removal of the Adrenals. Jour. Exper. Med., 1916, vol. xxiii, pp. 203–210.

[9] Mann, F. C., and Kawamura, K.: An Experimental Study of the Effects of Duodenectomy. A Preliminary Report. Jour. Am. Med. Assn., 1919, vol. lxxiii, pp. 878–880.

[10] Mann, F. C., and Kawamura, K.: Duodenectomy. ANNALS OF SURGERY, 1922, vol. lxxv, pp. 208–220.

[11] Rosenow, E. C.: The Causation of Gastric and Duodenal Ulcer by Streptococci. Jour. Infect. Dis., 1916, vol. xix, pp. 333–384.

[12] Taylor, F. J.: Duodenal Ulcer in the Dog. Vet. Jour., 1922, vol. lxxviii, pp. 343–344.

THE RELATIONSHIP BETWEEN CERTAIN FORMS OF INTESTINAL OBSTRUCTION, CHRONIC PERITONITIS AND CHRONIC MULTIPLE SEROSITIS*

By Charles N. Dowd, M.D.
of New York, N. Y.

In 1908, before the Surgical Section of the American Medical Association, Dr. Miles F. Porter[1] of Fort Wayne, Ind., and Dr. William H. Welch of Johns Hopkins University, presented a remarkable specimen of an intestine which had become so shriveled up by an investing " false membrane " that intestinal obstruction and death resulted. The investing membrane covered the entire small intestine and part of the large intestine. It was grayish-white, rather strong, about 1 mm. in thickness, almost cartilaginous and translucent over most of its extent. The peritoneum was replaced by this organizing exudate and connective tissue. The process of contraction had absorbed 70 to 80 per cent. of the length of the small intestine, the mucous membrane had correspondingly been puckered up into transverse folds so that the lumen was practically obliterated. When the " false membrane " was divided by numerous transverse cuts, the corresponding part of the intestine could be pulled out to its original length and the infolding of mucous membrane disappeared.

The etiology was not understood. No similar condition had been seen by those who studied the case. Doctor Welch's pathologic diagnosis was " Chronic organizing peritonitis of unrecognized etiology; intestinal obstruction resulting from numerous transverse infoldings or constrictions of the intestinal wall, these being held in place by bridges of dense organizing false membrane."

The uncanny thought of a contracting investing membrane slowly shriveling up one's intestines until he must die, naturally made a vivid impression on those who saw the specimen, and each one probably hoped he would never see a similar case.

My own turn for the similar case came thirteen years later.

Case Report.—On May 11, 1921, a man of forty-six was transferred from the medical to the surgical division of the Roosevelt Hospital (History A18153). He complained of pain and a mass in the lower part of his abdomen.

His health had been good until two years before, when he had noticed the mass, believing it due to a strain from lifting. It had been moderately painful. He had suffered from constipation and had lost 22 pounds in weight, but he had continued his work as a doorman until two days before admission. He then apparently had an attack of definite intestinal obstruction with great pain and excessive vomiting. The attack lasted for 12 hours. The pain was cramp-like and its maximum intensity was at the location of the tumor. Following it, he had bowel movements, but was so ill as to seek relief in the hospital. Routine physical and laboratory examination revealed no abnormality, excepting the mass in the lower part of the abdomen

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* Read before the New York Surgical Society, December 13, 1922.

about 25 by 10 cm. in its diameters, oval, dull on percussion, slightly movable, slightly tender, its centre below the umbilicus. There was a distinct depression between it and the pubes.

Catheterization of both ureters; pyelograms and cystograms; and X-ray pictures of the colon revealed no abnormality.

He was serving in the British Army when the mass was first noticed, otherwise no important element was found in either his personal or family history.

Operation, May 14, 1921.—Eight inch incision through the inner portion of the lower part of right rectus. Peritoneum could not be distinguished as a definite

FIG. 1.—Tumor composed of four-fifths or more of the small intestine, shortened, convoluted and angulated by a dense, investing fibrous membrane.

layer. Numerous indefinite thin portions of tissue which apparently represented peritoneum and which had evidently been the seat of some form of inflammation were present. These encased a lobulated irregular mass which was about 24 cm. long and 10 cm. wide. It was a long time before its nature could be made out. In its posterior wall, there was a small calcareous nodule.

On delivering it little by little and separating the adventitious pseudo-peritoneum, the retroperitoneal space was exposed. It was finally found that the tumor was composed of convoluted and adherent small intestine bound into an irregular mass by some peculiar pathological process.

The intestine which entered it from above looked fairly healthy but was moderately distended. The terminal 20 cm. of the ileum emerged from it below. It was manifest, that life could not continue with the intestine thus obstructed and hence the mass was removed after clamping and cutting the intestine above

and below. The upper (afferent) intestine was adherent to the right kidney and was separated from it with considerable difficulty. Its open end was then inserted through the wall of the ascending colon near the caput coli, forming an end-to-side anastomosis, secured by two rows of stitches. The open end of the lower (efferent) intestine was inverted and secured by purse-string sutures.

The patient did well for a few days, then a leak occurred at the site of the anastomosis. Thin fluid with much digestive power leaked away and on the 33rd day he died of inanition.

The appearance of the mass after its removal is shown in Fig. 1. *Gross Pathologic Report.*—It was lobulated, mostly firm in its consistency, but soft in some spots. It was composed of constricted, convoluted, angulated small intestine and shriveled mesentery, all bound together by dense adhesions and bands of fibrous

FIG. 2.—A portion of the intestine pulled out so as to show the appearance of the convolutions.

tissue (Fig. 2). When cuts were made into the intestine it was impossible to follow its lumen far on account of the angulations. In the mesenteric border there were some calcareous nodules.

When the intestine was cut across it was seen that the puckered mucous membrane nearly filled its lumen, as shown in Fig. 3. The appearance of the folds of mucous membrane is shown in Fig. 4. Apparently the contracting fibrous tissue outside the main intestinal wall had puckered and infolded the mucous membrane within. This appearance corresponded closely to Doctor Welch's description, but this infolded mucous membrane was not so firm nor was the investing membrane so definite as in his case. The investing membrane was irregular in its contour and could not be stripped off as a definite sheet. Nor was it possible to restore the intestine itself to its original length by making multiple incisions in this membrane, since it was too adherent to the intestinal wall to be satisfactorily separated. There was, however, a sausage-like feel to the intestine where its lumen had been filled up by the puckered mucous membrane. Those who saw the original specimen estimated that three feet or possibly a little more of the intestine had been removed. This was manifestly a very defective estimate, unless the intestine was congenitally short some fifteen or more feet of its length must have been shrivelled into this contorted specimen. This corresponds to the statement of Porter and Welch that 70 to 80 per cent. of the intestinal length in their specimen had been absorbed by this process of contraction.

Autopsy Report.—A limited autopsy was permitted through the site of the operation incision. It was reported that the peritoneal cavity had been completely obliterated. At the site of the anastomosis between the jejunum and the ascending colon there was a small leak (5 mm. wide) with necrotic tissue about it. The length of the intestine above the anastomosis was only 16½ inches. The stomach,
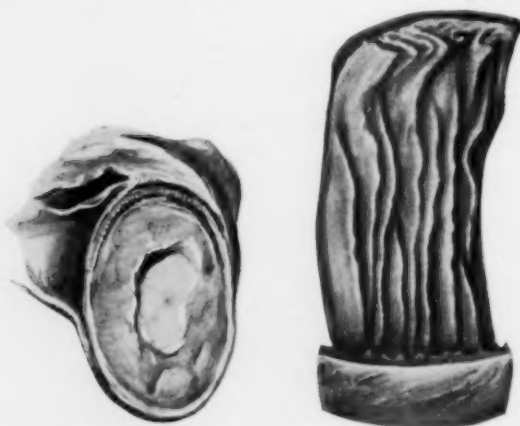
liver, pancreas, spleen and kidneys were not removed but their size and position were apparently normal.

It is believed that digestive quality of the fluid in the upper part of the jejunum was an element in the breaking down of the anastomosis and in the necrosis about it.

It is surely most remarkable that this pathological process could have contracted the greater part of the small intestine into a firm mass not much larger than two good fists.

Sections were cut from the intestinal wall; the microscopical slides are depicted in Figures 5, 6, 7.

Microscopical Report.—By Dr. Wm. C. White and Charles W. Lester, Roosevelt Hospital, May and June, 1921. History number A 18153. Pathological number S. A. 8924. Sections were cut through the intestine both longitudinally and transversely at: (1) the portion whose lumen was practically occluded, (2) various more proximal portions whose lumen was patent but where the intestine was coiled by a veil of adhesions.

1. The section through the portion whose lumen was occluded shows all four intestinal coats. The peritoneal coat was thickened and fibrous, in some places being 1 mm. in thickness. Numerous engorged blood-vessels were present in this layer. There was no evidence of tubercle formation.

Figs. 3 and 4.—Cross section of the intestine, showing the lumen almost occluded. Short section of intestine cut longitudinally and opened so as to show the folds of puckered mucous membrane.

The muscular layers were separated by a thickened fibrous layer. Otherwise the appearance was essentially normal.

The mucosa and submucosa showed the most marked changes. The mucosa was apparently very redundant, and extended into the lumen in great papillæ, like exaggerated valvulæ conniventes. These were rather tortuous in their course and were so extensive as to nearly fill the lumen of the gut. The valvulæ were supported by a vascular connective tissue core derived from the submucosa. The muscle tissue did not enter into this formation at all. The epithelium and glands formed the usual villæ and were normal in appearance.

2. The sections through the coiled loops of intestine with patent lumen showed a muscularis essentially the same as in the portion just described. The mucosa and the submucosa while somewhat redundant were not nearly so much so as in the distal occluded portion. There were a few exaggerated valvulæ conniventes, but for the most part the mucosa closely approached the normal. The peritoneal coat, however, was thicker and in addition was connected with a loose fibrous tissue which bound together the adherent coils. Sections of the investing membrane were stained by the Ziehl-Neelson-Gabbett method and searched for tubercle bacilli—none were found.

Diagnosis:—1. Chronic plastic peritonitis.
           2. Redundancy of intestinal mucosa.

The condition was so unusual that it seemed desirable to have the literature searched for similar cases. Dr. Charles W. Lester has spent many hours in such search, mostly under the heading of "Chronic Peritonitis" and "Intestinal Obstruction." The case which most resembled this was reported by J. C. Muir.[2]

A girl, fifteen, who was operated upon for partial intestinal obstruction had a mass of tangled coils of intestine resected. The peritoneal coat of the gut was thickened and inflamed with many small tubercles present, which, however, did not

FIG. 5.—Longitudinal section of intestine (low power) showing investing membrane and the mucous membrane raised into transverse folds. A. Investing fibrous membrane. B. Longitudinal muscular coat. C. Circular muscular coat. D. Submucous layer. E. Blood-vessels in submucosa. F. Folds of mucous membrane.

have the appearance of tuberculous peritonitis. The adherent portion was resected to within about two inches of the ileocæcal valve, and an end-to-end anastomosis done. When the resected portion was straightened out it was estimated to be four feet in length. Ten weeks later she died of inanition, and at autopsy it was found that the remaining small intestine from the pylorus to the ileocæcal valve measured only 17 inches. The peritoneum was thickened and showed the spots which are described as tubercles, but they did not show tuberculosis on microscopical examination.

Osler and Nicholls have given the best pathological descriptions which we have found. Osler [3] in his *Principles and Practice of Medicine,* in the chapter on "Proliferative Peritonitis," in which he refers to polyserositis, states that "there are instances of chronic peritonitis in which the mesentery is so shortened by this proliferative change, that the intestines form a ball not larger than a cocoanut, situated in the middle line, and after the removal of the exudation, can be felt as a solid tumor. The intestinal wall is greatly thickened and the mucous membrane of the ileum is thrown into folds like the valvulæ conniventes."

Adami and Nicholls[4] writing of chronic hyperplastic peritonitis state that "the mesentery may also be shortened so that the intestines lie in a ball close

to the vertebral column." "Occasionally there is no fluid exudate and the whole abdominal cavity is obliterated by adhesions of the visceral and parietal layers of peritoneal membrane."

Nicholls[5] also in an important paper before the American Medical Association calls "attention to a peculiar form of chronic peritonitis of progressive development, several instances of which have come under my notice recently." "The feature, however, that gives the affection its characteristic form is a peculiar overgrowth of fibrous tissue on the peritoneal membrane and the
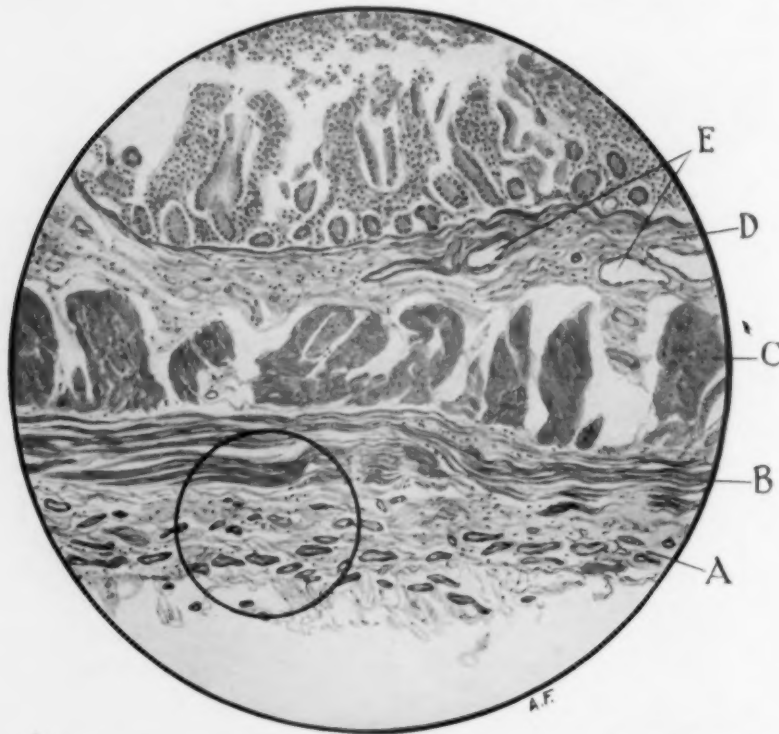
FIG. 6.—Higher magnification. Portion of intestinal wall shown within small circle in Fig. 5. Lettering same as in Fig. 5.

surfaces of the abdominal viscera, leading to induration and deformity. This fibrous tissue undergoes hyaline transformation so that plaques or continuous sheets of pearly white cartilaginous appearance are produced in various parts. The material in question has every feature of newly formed tissue, and the disease is both chronic and progressive. Shrinkage of the fibrous tissue takes place, hence one might correctly speak of the disease as chronic indurative peritonitis." The process is usually most marked about upper part of peritoneal cavity, liver, spleen, omentum, mesentery and may even extend to the pleural and pericardial cavities. "Although not new, the subject is one that has attracted but little attention in proportion to its importance. Ascites usually calls clinical attention to it, and somewhat resembles cirrhosis of the liver."

The quotations from Osler, Adami and Nicholls are under the headings of some form of chronic peritonitis, but these authors in the same connection refer to a particular form of chronic peritonitis which is combined with inflammation of other serous membranes—especially the pleura and pericardium.

This form of inflammation has been distinctive enough to receive an especial name, in fact several names have been given to it. Nicholls [6] calls it multiple progressive hyaloserositis and definitely refers to it in the above quotation. The
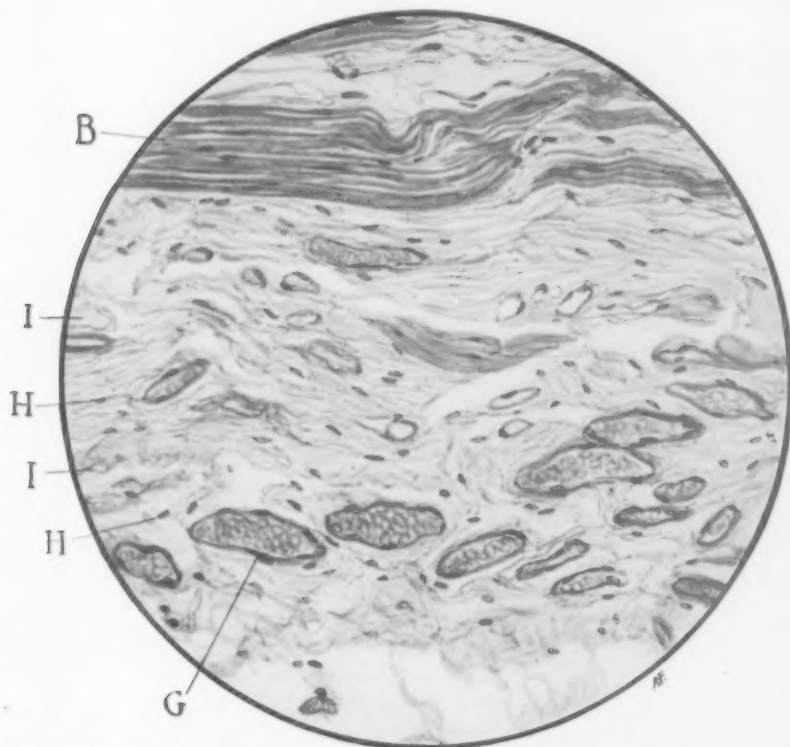
FIG. 7.—High magnification of the portion of fibrous investing membrane and longitudinal muscular coat shown within the small circle in Fig. 6. G. Blood-vessels in fibrous investing membrane. H. Small round cells. I. Fibrillar connective tissue.

subject is so intimately associated with our localized intestinal peritonitis that it should be described before proceeding further.

Chronic Multiple Serositis.—For at least three-quarters of a century surgical and medical literature has contained occasional references to this peculiar inflammation of the serous membranes, slow in its progress and leading to the formation of firm layers of fibrous tissue where the serous membranes had previously been and in certain localities to the adhesion of opposing serous surfaces.

The most common sites of this inflammation have been in the abdomen, especially in its upper part, in the pleural cavities and in the pericardium. The inflammation in the upper part of the abdomen has led to the adhesion of the

upper surface of the liver to the diaphragm and to the encasement of the liver and sometimes of the spleen in a " firm membrane which is composed of dense layers of connective tissue of a peculiar cartilaginous appearance." This fibrous encasement has been very firm. The inflammation in the pleura has led to the obliteration of part or all of one or both pleural cavities. The inflammation in the pericardium has caused the obliteration of the pericardial sac and in at least one instance (Kelly[7]) this process has gone to the stage of calcification so that a large section of the heart has been encased in a calcareous sheath.

Various names have been applied to this condition: Multiple progressive hyaloserositis (Nicholls); Chronic deforming perihepatitis; Zuckergussleber (icing liver) (Curschmann); Pericarditic pseudocirrhosis of the liver (Pick); multiple serositis (Kelly); Chronic multiple serositis (Mayo).

It is noted that the liver is referred to in many of these descriptive titles. The encasement of this organ in a dense layer of fibrous tissue is a prominent part of this remarkable pathological process. Pick's name is often used in describing the disease, although most observers ascribe less importance to the pericardial inflammation than he does. Curschmann's name is also frequently used in connection with the term " zuckergussleber."

Ascites has been the most prominent symptom. Many of the patients have had the ascitic fluid withdrawn time after time, 301 times in one instance. It is believed that many patients with supposed cirrhosis of the liver have really had this form of serositis. Symptoms referable to the heart and to the pleura have been next most common. The disease has been chronic and patients have gradually lost strength, the character of the symptoms depending on the site of the maximum inflammation.

The disease is a rare one, although Nicholls believes it not quite so rare as is generally supposed. Since ascites is the only symptom which has ordinarily led to a diagnosis, it is manifest that in the absence of ascites a considerable degree of inflammation could exist without the making of a diagnosis.

The resemblance between this condition and tuberculous peritonitis has caused considerable confusion, e.g., Picchini,[10] in considering 110 cases under the term " Polionomenite," really refers to tuberculous peritonitis in most instances, and Concato [11] has reported on " Polionomenite Scrofulosa." In 1903 Kelly,[7] in a masterly résumé of the subject, using the title " Multiple Serositis," tabulated 39 cases, at least eight of which were tuberculous. Nicholls states that " it is quite possible for the tubercle bacillus to produce a hyaline and productive fibrosis of the peritoneal membrane quite comparable to the simple form previously described " and quotes cases of Strajesko and Herrick for examples.

It is noteworthy that a disease which is characterized by the formation of extensive firm layers of fibrous tissue within the abdomen should interfere so little with the intestinal function, or at least that there should be so few reports of such interference. These fibrous layers are located mostly in

the upper part of the abdomen, but there seems to be no natural line of demarcation between that and the lower part of the abdomen. When there is so much of this fibrous tissue above we would naturally expect some below. As a matter of fact, we do find continual reference to such deposits, *e.g.*, Kelly states of his case, " The coils of intestine are united to one another and to the other intra-abdominal organs by moderately firm though friable fibrinous adhesions. In some places an exudate may be stripped off in thin layers." In his tabulation of 39 cases, there are many references to adhesions in various parts of the abdominal cavity. This year Mayo [12] called attention especially to the abdominal manifestation of " Chronic Multiple Serositis," in a paper read before the American Surgical Association. He referred to a patient who, in addition to the glistening white membrane in the upper part of the abdomen, also had the area of the small intestine " surrounded by a sheath of thickened peritoneum which bound the intestine down to the spine and resembled the flattened crown of a derby hat."

Nicholls describes a case in which in addition to the dense deposits in the pleura, pericardium and upper part of the abdomen, the parietal peritoneum was thickened, the mesentery was shortened and thickened, and " the intestines lay bunched along the vertebral column." The small intestines were short and the rugæ pronounced.

Jabez Jackson,[13] in his article on " Membranous Pericolitis " and allied conditions of the ileocæcal region, refers to a case which has bearing on the subject. " In one instance at least the membrane was a solid sheet of fibrous tissue, perfectly opaque and entirely obscuring the entire ascending colon and hepatic flexure which could not be recognized at all, until the membrane was divided and stripped away. Then we discovered a small, contracted, atrophied colon which we believed incapable of restored function. In this case we excised the entire ascending colon, including the hepatic flexure, and made an anastomosis between the ileum and transverse colon. Thus, entirely curing our patient."

Thus, in studying the reported cases we find that there is no lack of fibrous deposit about the intestines, but rather that the intestine shows a remarkable power of adjustment in continuing to function so long in spite of these constrictions. This is in marked contrast to the occasional result of local adhesions, for we all have seen angulation and complete obstruction caused by strands of fibrous tissue hardly thicker than knitting needles.

Etiology.—It is generally believed that the production of this fibrous membrane is due to the action of microörganisms of low virulence. Pneumococcus, B. Coli, B. Typhi, B. Tuberculosis, are the most likely offenders.

Without doubt many of the reported cases have been due to tuberculosis. But there is marked difference between this dense whitish cartilage-like membrane and the ordinary product of tuberculosis. Nicholls has described a case in which he believes the inflammation came from the gall-bladder and believes that this is not an uncommon source of the infection. He believes that the

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lymph spaces are followed in the syndrome which comprises upper abdomen, pleuræ and pericardium.

It is also suggested that the formation of this membrane is due to toxins which are developed within the liver or within other abdominal organs. With our present knowledge it is manifestly impossible to prove such an hypothesis. We may well agree with the statement that Doctor Welch made in a discussion of Doctor Nicholls' paper to the effect that the "etiology is very obscure."

SUMMARY

1. There are a few recorded cases of chronic peritonitis which has agglutinated the small intestines into relatively small globular masses.

2. The intestinal mucous membrane becomes puckered into folds and eventually occludes the intestinal lumen.

3. The outside appearance of this mass gives little indication of the real length of intestine which it contains. Four-fifths of the small intestine may be contracted into a mass which apparently contains about one-fifth.

4. The cause of this peritonitis is not definitely known, but it is believed to be due to a low grade of infection or to the toxins of such infection. In certain instances the inflammation may have been tuberculous.

5. There are many points of resemblance between this process and inflammation known as chronic multiple serositis. Indeed, similar intestinal peritonitis has in certain instances formed a part of chronic multiple serositis.

BIBLIOGRAPHY

[1] Porter, Miles F., and Welch, Wm. H.: (Transactions of the Section on Surgery and Anatomy, A. M. A., 1908, p. 202.)

[2] Muir, J. C.: A Case of Extraordinary Shortness of Small Intestine. (British Medical Journal, 1914, (July 11) vol. ii, p. 73.)

[3] Osler, Sir William: The Principles and Practice of Medicine. 8th Ed. p. 606.

[4] Adami and Nicholls: Principles of Pathology, vol. ii, Systematic Pathology, 1909, p. 507.

[5] Nicholls, Albert G.: Some Rare Forms of Chronic Peritonitis Associated with Productive Fibrosis and Hyaline Degeneration. Journal A. M. A., Mar. 14, 1903, vol. xl, p. 696.

[6] Nicholls, Albert G.: On a Somewhat Rare Form of Chronic Inflammation of the Serous Membranes. (Multiple Progressive Hyalo Serositis) Studies Royal Victoria Hospital, Montreal, vol. i, No. 3, 1903.

[7] Kelly, A. O. J.: On Multiple Serositis. Am. Jour. Med. Sc., 1903, vol. cxxv, p. 116–148.

[8] Pick F.: Unter Chronische, unter dem Bilde der Lebercirrhose verlanfende pericarditis. Zeitsch. f. klin. Med., 1896, vol. xxix, pp. 385–410.

[9] Curschmann, H.: Zur Differential-Diagnostik der mit ascites verbundenen Erkraukungen der leber und des Pfortadersystems. Deutsch. med. Wochenschr., 1884, vol. x, p. 164.

[10] Picchini L.: La Polionomenite sub acute elenta. Il Morgagni, Milano, 1891, vol. xxxiii, pp. 608–653–725. 1892, vol. xxxiv, p. 69.

[11] Concato: Gios Internat. della Scienze Medica 1881, Napoli N. S., pp. 1037–1053.

[12] Mayo, W. J.: The Peritoneal Manifestation of Chronic Multiple Serositis, Concato Disease. ANNALS OF SURGERY, Oct., 1922, vol. lxxvi, p. 432, No. 4.

[13] Jackson, Jabez N.: Membranous Pericolitis and Allied Conditions of the Ileocæcal Region. ANNALS OF SURGERY, vol. lviii, No. 3, p. 374, Mar., 1913.

GASTRO-COLIC FISTULA

By George P. Pratt, M.D.

of Omaha, Nebraska

FROM THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF NEBRASKA

Voorhoeve[1] found 105 cases of gastro-colic fistula reported in the literature up to the year 1912. The principal contributors of this study were Murchinson, who reported the first case in 1857, Bec,[2] Koch,[3] Port and Reizenstein,[4] Chavannaz,[5] Roger, and Menuet. Since then four cases have been added by Saucerotte;[6] four by Strauss;[7] three by Clairmont,[8] and one each by Burnham,[9] Axtell,[10] Haudeck,[11] Nahan,[12] Minkowski,[13] Neumann,[14] Groeschel,[15] Limbart,[16] Heinz,[17] Noordenbos[18] and Firth.[19] We are contributing one more case report of gastro-colic fistula which was due to carcinoma of the colon.

Inasmuch as Brinton observed eleven cases of this complication in 507 autopsies of gastric cancer, a frequency of 2.77 per cent., and since Dittrich in 106 carcinomata of the stomach found six gastro-colic fistulæ, a frequency of 3.75 per cent., we feel that the condition occurs more frequently than the literature would lead one to believe. Many cases are not diagnosed and many not reported. Crummer has handed me a case report, he studied clinically and at autopsy in 1908, which was never reported. Bland Sutton, in his recent book "Tumors Innocent and Malignant," states "the close approximation of the transverse colon to the gall-bladder and to the stomach must be borne in mind, because a primary cancer of the gall-bladder sometimes implicates the adjacent section of the colon, and it is not uncommon for a cancerous growth in the colon to invade the stomach, and vice versa."

In considering the etiological factors of these fistulæ, we have purposely omitted percentages. A study of the material at hand leads us to classify the causes in the order of frequency as follows: First, cancer; second, ulcer; third, following gastro-enterostomy; fourth, abscess in the peritoneal cavity; fifth, tuberculosis, and lastly, congenital anomalies. When due to cancer the primary lesions are more common in the stomach than in the colon.

The anatomical characteristics of the lesion are very variable according to its cause. Most of the time the autopsies disclose a more or less intimate connection between the stomach and the colon; the viscera are united on a fairly large surface. In other cases there is an intermediate cavity surrounded by adhesions through which the stomach and colon communicate. One finds all forms and sizes of fistulæ. The communication may be direct or is made through a long and tortuous passage. The fistula may be small, only admitting a probe, or sometimes it is large enough to admit a fist. When due to cancer the communication is most common between the transverse colon and the stomach near the pylorus on the greater curvature. One case of double gastro-colic fistula was reported by Fabeck.

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Abdominal pain and discomfort of a vague type, abdominal distention, offensive eructations, fecal vomiting, lientery, and the similarity of the vomitus and the stools should arouse suspicion of a gastro-colic fistula. Confirmation of this suspicion is not difficult and can be made by the following procedures: Loss of fluid by gastric lavage similar to that seen in some cases of hour-glass stomach; recovery of fecal material by lavage; recovery from the stomach of colored matter administered as an enema; barium meal with X-ray examination and a barium enema with the contrast meal found in stomach.

History.—Case No. 7155. O. C., male, married, age thirty-four, was admitted at the University Hospital, October 29, 1921, complaining of weakness, abdominal pain, an abdominal tumor, vomiting and diarrhœa. The weakness had gradually increased during the past year and there has been considerable loss of weight. Seven months ago the patient noticed a swelling in the abdomen, just above and to the left of the umbilicus. One month later this mass became extremely tender with more or less constant pain in the left hypochondrium. During the last three months the pain became exaggerated after eating, so that the more undigestible foods have been excluded from his diet. Vomiting at irregular intervals commenced ten days ago, increasing during the last five days. There were from five to six dark, watery stools a day. The stools and the vomitus, the patient states, are the same, describing both to be dark brown, of liquid consistency, with the same disagreeable odor.

Past History.—Negative.

Family History.—Negative.

Physical Examination.—The patient, a comparatively young man, appears quite ill, pale and markedly emaciated. The temperature is 99.2; pulse, 84; respiration, 20. The pupils are equal and active; mucous membranes of the nose and throat are pale; cervical glands not palpable; thyroid normal. The lungs are resonant throughout and the breath sounds normal. The apex beat is located in the fifth interspace, just inside the mid-clavicular line. No cardiac murmurs are heard and the heart sounds are clear. The pulse is regular but not strong. The abdomen is not distended and the walls are quite relaxed. There is a mass easily palpable, somewhat tender, about the size of a large orange, rather firm, irregular and nodular, just above and to the left of the umbilicus. This mass is freely movable in all directions. There is no expansive pulsation.

The temperature ranged before the operation between normal and 100° F. The respirations are normal and the pulse varied from 85 to 100. The blood-pressure is: Systolic 100, diastolic 58. The urine is acid in reaction; specific gravity 1.020; albumin negative; sugar negative and the microscopic examination negative for casts, pus and blood cells. The blood Wassermann is negative; hæmoglobin, 52 per cent.; red blood cells, 2,990,000; leucocytes, 11,200; differential normal. Stools are dark brown, containing much blood; microscopic and benzidine tests. The vomitus is dark brown in color, contains occult blood and has a fecal odor. There is an absence of free hydrochloric acid. The fæces and the vomitus are apparently the same material, and placed side by side one could not differentiate one from the other.

The X-ray examination shows barium passing immediately from the stomach to the transverse colon. (Fig. 1.)

Diagnosis.—The condition was diagnosed clinically as an anastomosis between the stomach and colon associated with carcinoma.

Operative Report.—The patient was examined by Dr. A. F. Jonas and an exploratory laparotomy decided upon. The operation was made November 2, 1921, and reported as follows: "An incision was made about six inches in length
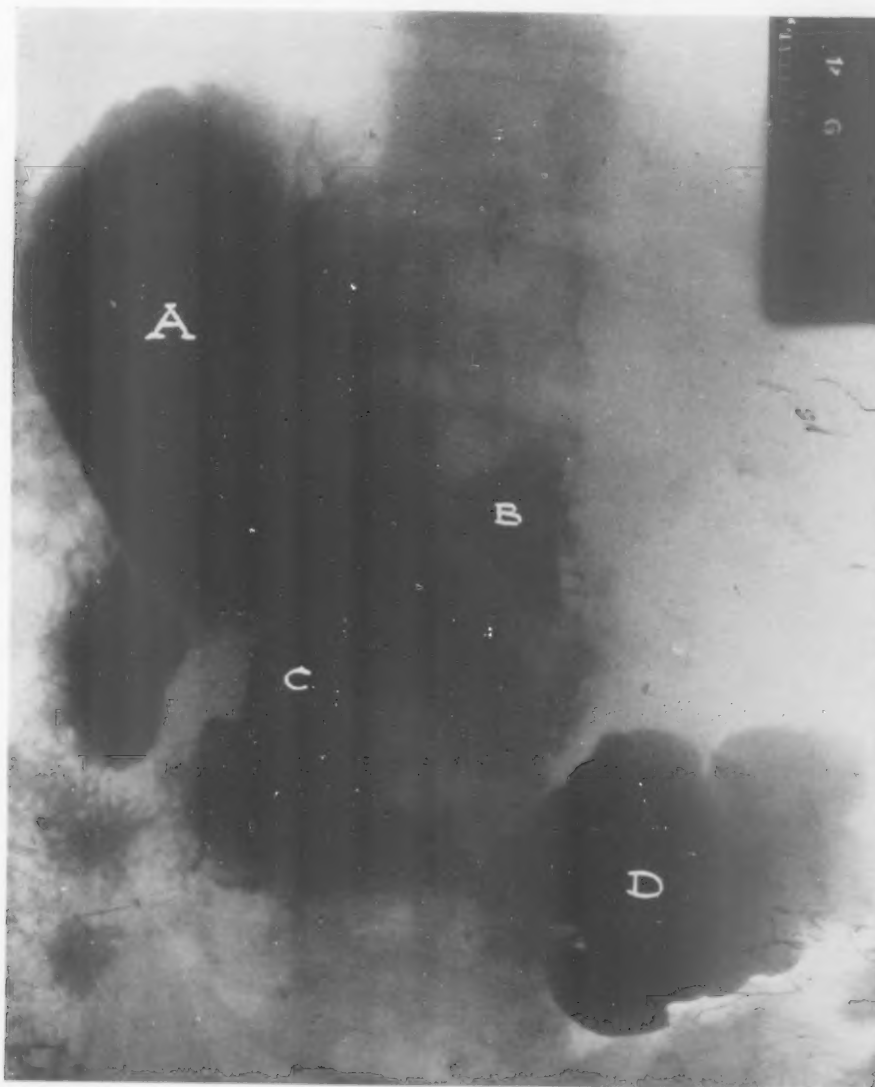
Fig. 1.—A. Stomach. B. Duodenal cap. C. Fistula. D. Transverse colon.

into the abdomen, through the right rectus muscle, above the level of the umbilicus. A freely movable tumor mass was found under the left costal arch, which proved to be a large carcinoma involving the entire circumference of the transverse colon and a small area of the greater curvature of the stomach by direct extension. A direct opening from the stomach into the transverse colon was demonstrated by invaginating the stomach with the index finger and inserting

it into the transverse colon. There was an extensive involvement of the retro-peritoneal glands all along the spine. Enlarged and hard glands were felt in the gastro-hepatic omentum. The pylorus and duodenum were free and unobstructed. Abdominal wall closed.

Necropsy Report.—The necropsy made by Doctor Keegan, November 26th, was without interest except for the abdominal findings which were recorded as follows: There is a healed recent surgical incision to the right of the middle line between the ensiform process and the umbilicus. The abdominal wall is thin. The peritoneum is smooth and glistening. There is no free fluid. The stomach is considerably distended and is found adherent to the transverse colon near the splenic flexure. On opening the stomach there is found an opening 3 to 4 cm. in

Fig. 2.—View from within the stomach showing opening of the fistula.

diameter communicating with the lumen of the transverse colon. (Fig. 2.) This opening is situated along the greater curvature of the stomach about six inches from the pylorus. Its edges are smooth, rounded and of moderate firmness. There is no ulceration evident nor extensive infiltration of the stomach wall. The pylorus is patent. The remaining mucosa of the stomach appears normal. On lifting the great omentum there are numerous adhesions to the tumor mass situated in the wall of the transverse colon. Numerous lymph-glands along the lesser and greater curvature of the stomach and the retroperitoneal glands are large, white, firm and nodular. On separation of the first portion of the jejunum from the transverse colon, where it had become more adherent, a small pocket of creamy pus and a communication into the lumen of the colon are found. The transverse colon was laid open and a rather soft, ulcerating nodular tumor is found involving the wall a distance of about four inches, extending through its entire circumference. There is no marked constriction of the lumen. The opening into the stomach observed previously was seen within the limits of the tumor. The small intestines are somewhat distended but appear quite normal.

The appendix is small and retrocæcal. The large intestines and other regions appear normal. The liver is of normal size, extending to the costal margin. It is rather pale, of a reddish-yellow color, and serial sections showed no tumor metastases. The gall-bladder is normal and the bile ducts are patent. The spleen is of normal size and consistency. The pancreas is pale and nodular. The kidneys are of normal size. The capsule strips easily, leaving a smooth surface. The cortex is of normal thickness with distinct striations and clear differentiations from the medulla. The adrenals are negative. The retroperitoneal glands are markedly involved with tumor metastases, especially at the base of the mesentery of the small intestine.

Frozen section of the tumor of the colon revealed a massive epithelial cell infiltration with suggestive alveoli but very little differentiation of cells.

Pathological Diagnosis.—Carcinoma of the transverse colon with perforation into the stomach, also with a walled-off perforation into the peritoneal cavity; extensive retroperitoneal metastases.

CONCLUSIONS

On account of the extreme annoyance of the accompanying symptoms and the disturbance of the digestive physiology with its inevitable fatal issue, an exploratory laparotomy is indicated. Surgery offers the only possibility of successful treatment. When carcinoma is the etiological factor, there is little hope that anything can be done, although Burnham reports a duodeno-colic fistula in which the carcinomatous colon was resected and the opening in the duodenum closed with a favorable result. "Six months after the operation the patient was free from symptoms, enjoyed good health and had gained fifty pounds in weight." The gastro-colic fistula following gastro-enterostomy, due to ulcer or peritoneal infection, offers a better prognosis. There is always the possibility that the causative pathology may be removed and the openings in the stomach and colon successfully closed.

BIBLIOGRAPHY

[1] Voorhoeve, N.: Deut. Arch. f. k. Med., vol. cvi, p. 294, 1912.
[2] Bec: These de Lyon, 1897.
[3] Koch, P. H.: Archiv f. Verd Krankheiten, vol. ix, p. 1, 1903.
[4] Port u. Reizenstein: Mitt. a. d. Grenzgeb. Med. u. Chir., Bd. vol. xvii, 1907.
[5] Chavannaz: Rev. de Gynec. et de Chir. Abd., vol. xi, p. 257, 1907.
[6] Saucerotte, H.: Contrib. a l'etude des fistules gastro-colique. Montpelier, 1912, No. 74; 66 pp.
[7] Strauss, H.: Berl. klin. Wchnschr., vol. lviii, p. 661, June 20, 1921.
[8] Clairmont, P.: Wien. klin. Wchnschr., vol. xxxiii, p. 285, 1918.
[9] Burnham, M. P.: Am. J. Roentgenol., vol. iv, p. 173, April, 1917.
[10] Axtell: Am. J. Surg. N. Y., vol xxiv, p. 190, 1910.
[11] Haudeck, Martin: Wien. med. Wchnschr., 1912, vol. lxii, p. 3103.
[12] Nahan, L.: Jour. de radiol. et d'electrol., vol. iii, p. 458, July-August, 1919.
[13] Minkowski: Berl. klin. Wchnschr., vol. lvi, p. 956, 1919.
[14] Neumann, Rudolph: Fortschr. a. d. Geb. d. Roentgenst., vol. xx, p. 398, 1913.
[15] Groeschel, L. B.: Am. J. Roentgenol., vol. viii, p. 516, Sept., 1921
[16] Limbart, W.: Munch. med. Wchnschr. vol. lxvii, p. 1321, Nov. 12, 1920.
[17] Heinz, A.: Deutsch. med. Wchnschr., vol. xlviii, p. 771, 1922.
[18] Noordenbos, W.: Hederl. Tydschr. v. Geneesk, vol. lxvi, p. 2386, 1922.
[19] Firth: Lancet, Lond., vol. i, p. 1061, May 15, 1920.

SLIDING HERNIAS OF THE CÆCUM AND APPENDIX IN CHILDREN

By Vernon C. David, M.D.

of Chicago, Ill.

There are many explanations offered to clarify the underlying causes of sliding hernia in which a portion of the large bowel, as the ascending colon or sigmoid, makes up a part or major portion of the sac of the hernia by reason of the small extraperitoneal portion of the bowel having descended into the scrotum, carrying with it the larger peritoneal portion of the bowel.

While hernias containing cæcum and appendix in their sacs are not very uncommon, real sliding hernias are rarely seen in children. Some of the factors underlying the development of sliding hernias of the cæcum and appendix in children will be considered.

Incidence of Cæcal Hernia and Sliding Hernia.—Coley in 2200 hernias found the cæcum alone in the sac in eighteen, the appendix alone in ten and the cæcum and appendix together in seven.

Judd [1] found fourteen sliding hernias in 1652 hernias and of these six were of the cæcum and on the right side.

Hilgenreiner,[2] in describing rare hernias occurring in the Wölfer clinic over a period of fifteen years, said they had observed twenty-two hernias of the cæcum, of which eight were of the sliding variety, in a total of 2238 hernias operated upon.

Baumgartner [3] collected 159 sliding hernias from the literature. Eighty-five were right sided. Four were left inguinal hernias containing the cæcum.

Hildebrand,[4] in an exhaustive study of the material in 1892, collected one hundred twenty-eight cases of hernia of the cæcum, eighty of which were right inguinal hernia, eighteen were left inguinal hernia and eleven were right femoral hernia. He found sixteen instances where the cæcum was present in right inguinal hernia in children. Of these, two were in the fœtus at the eighth month, two were in children over a year old and twelve were in children during the first year of life. The appendix was attached to the sac and testis in three cases. The ascending colon was adherent to the sac in two instances, but the cæcum was free of the sac in all of the cases.

The two most discussed factors in the causation of sliding hernia in children are the rotation of the cæcum and the descent of the testes during fetal life.

Rotation of the Cæcum and Ascending Colon.—The cæcum develops as a small diverticulum from the large bowel as early as the fifth week of fetal life, before axial rotation of the gut has taken place and while there is still a common mesentery. Axial rotation of the bowel now takes place and the cæcum, which is entirely covered with peritoneum, is found under the liver with the large bowel which is eventually to become the ascending colon. The large bowel now descends to the right and the lateral peritoneal aspect

of the ascending colon comes in contact with the posterior parietal peritoneum and fusion occurs between the two layers. The posterior aspect of the ascending colon thus becomes devoid of peritoneum, loses its mesentary and is fixed to the posterior abdominal wall. The cæcum and appendix remain covered with peritoneum but do not possess a true mesentery. According to McMurrick,[5] the fusion of the posterior parietal peritoneum and the lateral peritoneal covering of the ascending colon is incomplete in one-fourth to one-third of the cases examined by him. An incomplete fixation of the ascending colon, therefore, results.

Hildebrand[4] has observed in children that the ascending colon may be practically free and covered with peritoneum, though in adults this condition is more rarely found. It is usually stated that the appendix and cæcum reach their normal position in the abdomen about the seventh to eighth month of fetal life, although Treves[6] maintains that the cæcum, having reached its position underneath the liver during axial rotation of the bowel, remains there until the fourth month after birth, at which time the cæcum descends to the right iliac fossa. The

FIG. 1.—Sliding hernia of cæcum and appendix. (After Sprengel.)

finding of the cæcum in the patent vaginal process of peritoneum at the eighth month of fetal life makes the view of Treves somewhat doubtful.

While the cæcum is anchored in position by peritoneal folds described by Scarpa and Tuffier,[7] it has considerable freedom of motion which is dependent to a great degree on the fixation of the ascending colon to the posterior abdominal wall. The cæcum usually lies a little mesial to the middle of Poupart's ligament.

Descent of the Testicles.—Developing in the lumbar region, the testicles descend to the inner side of the anterior abdominal wall near the internal ring at about the fifth month of fetal life.

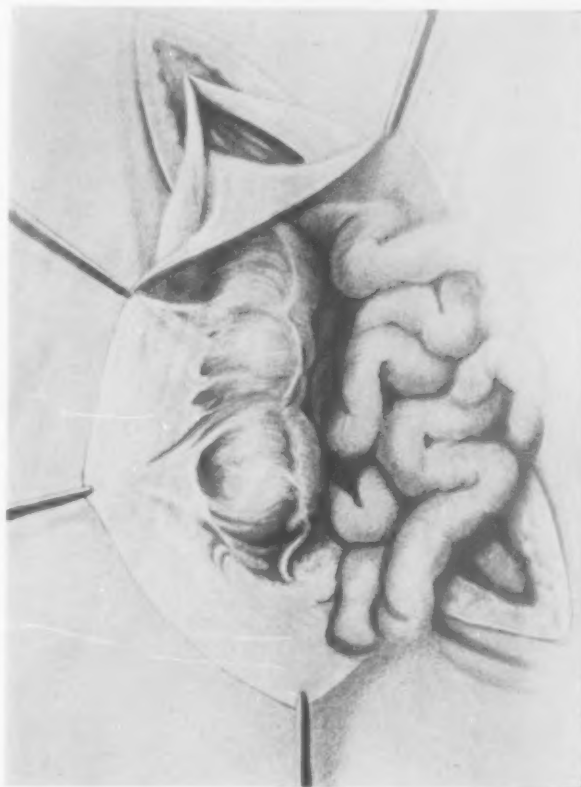The vaginal process of peritoneum is now formed and this descends into

the scrotum. The gubernaculum testis is attached to the bottom of this peritoneal process. Due to lack of further growth of the gubernaculi, the testes are drawn between the wall of the vaginal process of peritoneum and the infundibuliform fascia at about the eighth month of fetal life and at birth are usually found in the scrotum. It is important to note that the vaginal process of peritoneum is formed and descends into the scrotum before the testicles leave the inguinal canal. The upper part of the vaginal process is usually occluded at birth, the lower end forming the tunica vaginalis testis. A persistence of the vaginal process in its entirety forms the sac of the congenital type of hernia.

The embryological development of the ascending colon and the descent of the testicles have been particularly considered because of the belief that adhesions forming between the testicle and the cæcum and appendix during fetal life are responsible for the appearance of the cæcum and appendix in the hernial sac. Lockwood[8] describes a peritoneal fold, the plica vascularis, which runs from the mesorchium of the testicle along the posterior abdominal wall to end in the cæcum, appendix or mesentery. Persistence of this fold is a developmental defect. He suggests that in descent of the testicle, the cæcum is pulled down into the scrotum by this fold. He was able to demonstrate gubernaculum fibres passing into the plica vascularis in one child. Other observations have been made of adhesions between the cæcum and testicle, where the cæcum was in the hernial sac, as well as in cases of non-descent of the testicle.

FIG. 2.—Sac divided into an anterior and posterior portion.

Hutchinson and Piesol were unable to trace any direct connection between the plica vascularis and cæcum. Waldeyer[9] does not believe that there is a relation between the two. While many observations of adhesions between the

cæcum and testicle have been made, in most of them the testicles had already descended and it was difficult to say whether the adhesions had developed before or after descent of the testicles.

There are further objections to this theory. The vaginal process of peritoneum, which is the potential hernial sac, has already reached the scrotum before the testicle descends between it and the infundibuliform fascia. At the seventh month of fetal life, the testicles are just about to enter the inguinal canal. In order for the cæcum to become a sliding hernia and be incorporated in the sac of the hernia, which is already potentially present in the vaginal process of the peritoneum, it must be assumed that sufficient pull is exerted by the testicle in its descent to drag down not only the cæcum but also that part of the posterior parietal peritoneum which is between the adherent testicle and cæcum. This would mean that a portion of the posterior parietal peritoneum would be displaced from a position near the internal ring to the bottom of the scrotum where the testicle rests. It would seem more logical to assume that non-descent of the testicle would occur if no other factor

FIG. 3.—Posterior portion of sac lifted from its bed.

than these adhesions were active in the causation of the sliding hernia. Ransahoff also objects to the influence of the testicle in the formation of these herniæ because the testicle is separated from the gut by peritoneum and is the case of the ascending colon by a double fixed layer of mesocolon.

In the three cases of sliding hernia of the cæcum in children to be reported in this paper, there were no adhesions between the bowel and the testicle and no gross evidence of a plica vascularis was present.

As has been pointed out from the embryological side, the mesentery of the ascending colon may persist to a greater or less extent and this is especially true in children. This would allow an abnormal position of the cæcum to

obtain which in an extreme instance would allow the cæcum to be present in a left-sided hernia. While these deviations from normal explain the entrance of cæcum and appendix into hernial sacs in children, it does not clarify the conditions found in sliding hernia, *viz.*, that the bowel wall be incorporated in the hernial sac as part of the sac. There are several possible explanations to be given. First, and of doubtful importance, is the action of a fetal peritonitis which by formation of an exudate would so involve the sac and the prolapsed cæcum that in its resolution the two would become firmly united. If this condition were present it would seem logical to expect other evidence of the peritonitis than the mere union of the cæcum and hernial sac. The most plausible explanation to me is the possibility of fusion of the peritoneal surface of the cæcum, which has found its way into the hernial sac, to the peritoneum of the vaginal process in the same way that the lateral surface of the ascending colon and posterior parietal peritoneum become fused when the mesentery of the ascending colon is lost. This would assume that by an abnormal position of the cæcum in the vaginal process of peritoneum, a fusion of the
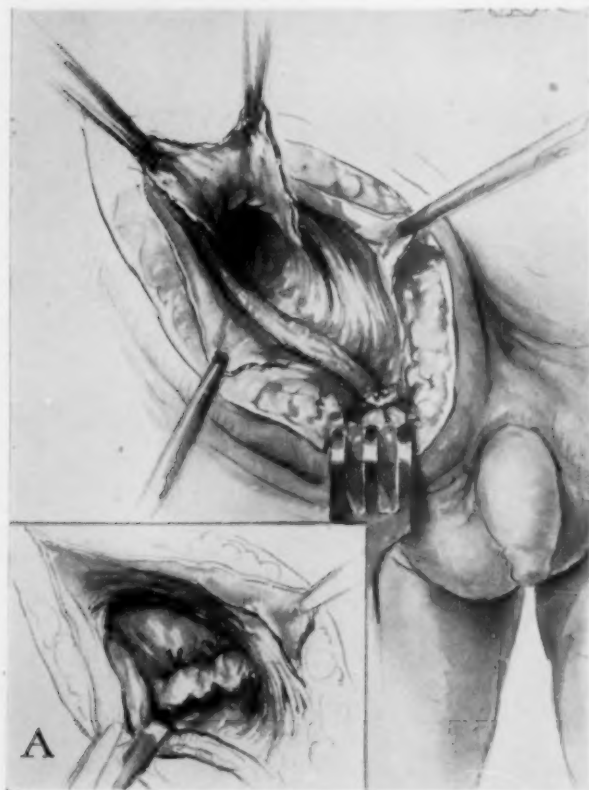

Fig. 4.—Posterior portion of sac reduced into abdomen. A—anterior portion of sac sutured over internal ring.

two apposing layers of peritoneum took place, so that the cæcum, which is normally free and devoid of mesentery, became part of the sac of a congenital hernia. A third explanation of the presence of the cæcum in a sliding hernia in childhood is found in the possibility of the fusion of the peritoneal surface of the cæcum to that part of the parietal peritoneum which later will become the vaginal process of peritoneum about the sixth to seventh month of fetal life and consequent descent of the cæcum into the hernial sac in this way.

Moschcowitz [10] maintains that bowel completely covered with peritoneum, as cæcum, cannot become part of a sliding hernia. This must be but a

matter of definition, for it is certain that the cæcum and appendix were incorporated in the sac of the hernias to be described and were part and parcel of the sac.

CASE I.—James P., boy, sixteen months of age. His mother discovered a swelling at the right inguinal region when he was eight weeks old. This swelling has increased in size and is irreducible.

Examination.—A right inguinal hernia reaching into the scrotum is present. The swelling is about the size of a pear and is only partially reducible. Owing to the danger of strangulation in a large irreducible hernia, operation was decided upon.

Operation.—July 7, 1922, Cook County Hospital, by Doctor David. Ether anæsthesia. Upon opening the anterior portion of the sac, several loops of small bowel as well as the cæcum and appendix were seen. The sac was a congenital one, connecting freely with the tunica vaginalis testis. The small bowel was reduced easily, leaving the cæcum and appendix, which formed the posterior wall of the sac. The cæcum extended well below the external inguinal ring and the appendix, which was six centimetres long, curled around the posterior scrotal surface of the sac, and comprised part of the sac in that it could only be removed from the sac by cutting the wall of the sac where it was attached. Neither the cæcum nor the appendix was connected with the testicle, which was in the normal position in the scrotum, by adhesions or by any vascular pedicle which might correspond to the plica vascularis (Fig. 1). From the inner wall of the sac contiguous to the cæcum, many fine blood-vessels ran over the convexity of the cæcum and appendix. The mesenteriolum of the appendix was not apparent. A slight vascular veil covered several portions of the appendix.

The hernial sac was divided transversely between the appendix and the testicle and the testicular portion closed by a purse-string, thus reëstablishing the tunica vaginalis testis. The appendix was removed in the usual way, removing the sac wall under the appendix. The sac was divided longitudinally (Fig. 2), leaving a posterior portion made up of cæcum and anterior portion of peritoneum. This longitudinal division was carried up to the internal ring. The posterior cæcal portion was now raised up from the cord and separated from the surrounding soft parts up to the internal ring (Fig. 3). The cæcum with loose contiguous edges of sac was now reduced (Fig. 4) into the abdomen through the internal ring and the anterior peritoneal portion was cut away, leaving only enough to imbricate and sew over the posterior denuded area of the reduced posterior half of the sac which was cæcum.

This same technic has been used in principle in sliding herniæ of adults. The literature shows that Henverswyn [11] is credited with first forming a mesentery for the cæcum from the posterior wall of the sac in 1893. Tuffier,[7] Wier,[12] Hotchkiss,[13] Walton,[14] Sprengel [15] have suggested the method anew or have modified the technic in some few details. In nearly all of these modifications, the edges of the sac contiguous to the bowel, comprising the posterior wall of the sac, were sutured behind the bowel before its return to the abdomen.

CASE II.—Boy, six years old. Right inguinal hernia present since infancy. Testicle in scrotum. Hernia irreducible. Appendix was palpated in the sac before operation. Operative findings and technic almost identical with Case I. There were no adhesions between the testicle and bowel nor was there any evidence of a vascular connection.

CASE III.—Boy, aged fourteen months. No history was obtainable. The cæcum alone was present in the sac. The bowel was not adherent to the testicle nor was there a vascular connection between the bowel and testicle. The reduction of the hernia was accomplished by the same technic as used in Case I.

BIBLIOGRAPHY

[1] Judd: Mayo Clinic Paper, 1909.
[2] Hilgenreiner: Beitrage z. klin. Chir., 1910, vol. lxix, p. 333.
[3] Baumgartner: Les hernies par glissement au gros intestine. Paris, 1905
[4] Hildebrand: Deutsch. Zeit. f. Chir., vol. xxxiii, S. 182, 1892. See for Tuffier reference.
[5] McMurrick, J. R.: Development of the Human Body. 1902.
[6] Treves, F.: Brit. Med. Jour., vol. i, 1885.
[7] Tuffier: Ref. to Hildebrand for quotation.
[8] Lockwood: Morbid Anat., Path. and Treat. of Hernia. 1899.
[9] Waldeyer: Virch. Arch. 1874.
[10] Moschcowitz:: ANNALS OF SURGERY, 1914, vol. lix, p. 610.
[11] Henverswyn: Jour. des Sci. Med. d'Lille, 1893, p. 121.
[12] Wier, R.: Med. Record, February 24, 1900.
[13] Hotchkiss: ANNALS OF SURGERY, vol. l, 1909, p. 410.
[14] Walton: ANNALS OF SURGERY, vol. lvii, p. 86.
[15] Sprengel: Arch. f. klin. Chir., 1911, vol. xcv, p. 702

MASSIVE VENTRAL HERNIA WITH FECAL FISTULA

By Horace S. Villars, M.D.

MAJOR MEDICAL CORPS, U. S. ARMY

WALTER REED GENERAL HOSPITAL, WASHINGTON, D. C.

THE following case of post-operative ventral hernia is reported because it is believed to be of unusual interest on account of its great size and the attending complications that existed at the time of operation.

The patient, admitted September 17, 1921, was a man thirty-two years of age, of the heavy, thick-chested and short-necked type, weighing two hundred and ten pounds. His occupation had been that of a steel sash erector prior to March, 1918, the beginning of his present trouble, and physically he was well adapted for such work. The physical examination showed his general condition to be excellent except for the lesion which caused him to seek admission to this hospital. This was an enormous ventral hernia accompanied by complete relaxation of all supporting structures on the right side of the abdomen and further complicated by a discharging fecal fistula at the lower pole of an old right rectus incision. The hernial protrusion (as shown in Fig. 1) was pendulous and, without exaggeration, as large as a man's head. The skin covering it was smooth, tense and shiny, and so thinned in the area of the old scar that peristalsis was as easily seen as felt. When the patient coughed, the whole mass seemed almost erectile, so visible was the impulse. There was a complete absence of subcutaneous fat over the area of the hernia, although on the left side of the abdomen, as over the remainder of his body, there was a superabundance of this tissue.

The material history of the development of this hernia began with an operation in another hospital for acute appendicitis March 3, 1918, in which a right rectus incision was used and closed without drainage by a continuous suture. On the fifth day this suture was removed, too soon in this instance, for the patient states the whole wound gaped wide so that the surgeon was obliged to use his hands to keep the intestines from protruding and adhesive strips were necessary to approximate the skin edges. The union of these tissues was complete in twenty days, but they served only as a covering for a post-operative hernia. The patient was held in that hospital until June 24, 1918, when a secondary operation was performed to repair this hernia. Five days later the wound broke down and a fecal fistula was established in the lower pole of the incision. This fistula persisted, and in September the man was discharged with a draining wound and a large ventral hernia. From that time until March, 1920, there was no change in his condition. The fistula and hernia remained as they were at the time of his discharge. At this time he went to another hospital in a western city and without any preliminary dieting or treatment was operated a second time for the repair of his hernia. In this operation, according to the statement of the surgeon, the sheaths of both recti were transplanted in an effort to reinforce closure. This attempt also was unsuccessful and the patient again was discharged, still in possession of both ventral hernia and fecal fistula. He then went to his home and remained there, enabled to move about by the use of an abdominal belt, until September 17, 1921, when he was admitted to Walter Reed U. S. Army General Hospital.

In brief, in the preceding three and a half years this patient had had his tissue resistance lowered by three major operations and by long-standing infection inci-

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FIG. 1.—The ventral hernia before operation.

dent to the fecal fistula; general adipose tissue had increased during his enforced idleness and, in all probability, the structures necessary for an adequate repair were rendered useless by the operations mentioned—an interesting but hardly an encouraging case to undertake to correct.

On his admission here he was put at once on a very restricted diet for the purpose of reducing his weight. At the same time his abdomen was firmly strapped with broad bands of adhesive tape in an attempt to force back and to hold the hernial contents—the small intestines—in their normal habitat. This strapping served the double purpose of an abdominal support and, more important, surgically, provided a means for the intestinal tract to become accustomed to the increased abdominal tension which would naturally follow any curative operation. At the end of eight weeks, November 3, 1921, this had been accomplished. The patient had been reduced twenty-five pounds in weight and was considered ready for operation.

Using ether as the anæsthetic of choice, the operation was performed by Lieutenant Colonel William L. Keller, Medical Corps. First a large elliptical flap of skin including the old scar and the external opening of the fecal fistula was excised. It was found that almost the entire small intestine was in the hernial sac and firmly adherent to the anterior wall, which was formed by the skin alone, the parietal peritoneum not being recognizable in that area. After a very difficult dissection, the intestines were freed from their skin covering and numerous constricting bands of adhesions between loops of the small bowel cut. Resection of the ileum was necessary at the point of the fecal fistula and again at a point above where it was impossible to relieve the constriction by dissection. A Bonnie tube was then introduced into the ileum just above this higher resection, as a precaution against distention, and secured by two purse-string sutures.

This much accomplished, closure of the wall was the next step. It was desired to cover the intestines with omentum as an aid in preventing the recurrence of adhesions, but that, too, had been used up in the previous operations. The vertical borders of what remained of the rectus abdominis and the oblique and transversalis muscles were dissected free, and closure of the muscular plane made by the lateral overlapping method, the Bonnie tube being brought out obliquely to avoid constriction. The skin incision was then closed with interrupted silkworm sutures, using rubber tissue drainage at the upper and lower poles and at the centre. The Bonnie tube was drawn out through a stab incision about three-quarters of an inch below and lateral to the centre of the skin incision. The abdomen was then tightly strapped, from pubis to sternum, with long strips of one-inch adhesive so as to take as much tension as was possible from the deep sutures. A gauze dressing was applied over the adhesive and the patient put to bed in the Fowler's position.

The technic of the operation completed, success was then dependent upon the post-operative procedures. The large quantities of gas that passed out through the Bonnie tube more than justified its use, and because of it the patient was remarkably free from discomfort due to gaseous distention. It was removed on the seventh day after operation, and superficial drainage instituted through the stab incision to care for a colon infection that had been expected in tissues which had suffered such infection for over three years. This complication was treated by irrigations with Dakin's solution twice daily and was soon cleared up. At no time was there any fecal discharge. There was considerable sloughing of subcutaneous tissues, as was to be expected where such extensive dissection had been carried out, but this gradually decreased and the entire wound healed without further accident, the muscular layer firmly united, forming an apparently adequate abdominal wall. Tension and support were maintained throughout convalescence by long adhesive straps which when necessary were removed one at a time from

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FIG. 2.—Result of operation for the cure of ventral hernia.

above downwards, each strap being replaced by a fresh one before the next was removed.

During the first week of his post-operative period, the patient developed a left lobar pneumonia, but this was successfully combated and no other complication was encountered during his entire convalescence.

On the first of February, 1922, the adhesive strips were replaced by a canvas belt and the patient allowed to be up in a wheel chair. He left the hospital on the first of March, 1922, his wound of operation firmly healed, the abdominal wall apparently adequate in its support, and with a cosmetic result that is shown in the accompanying photograph (Fig. 2).

Ten months after his operation he reported that his condition was excellent and that there were no signs of a recurrence of the hernia.

DOUBLE KIDNEY*
By Daniel N. Eisendrath, M.D.
of Chicago, Ill.

Definition.—There is still much confusion in the nomenclature of renal anomalies. The term unilateral fused kidney is applied by many to two quite different anomalies, namely: to those in which both kidneys lie on the same side of the body as well as to the cases in which there is a reduplication of the renal pelvis on one or both sides.

In the former (both kidneys on, or almost all on, the same side), the term crossed ectopia is the less confusing one to employ, because the lower of the two kidneys represents the congenitally displaced or ectopic kidney of the opposite side. The more or less complete fusion in crossed ectopia is the result of a displacement of one kidney during embryonic life and not that of a reduplication of the embryonic ureteral bud with the formation of a permanent kidney around the cranial end of each of the two ureters which may arise

Fig. 1.—Pyelonephritis in lower pole of a kidney, having two pelves, and two ureters, but no separation of the parenchyma. (Author's case.)

from the same ureteral bud. This latter condition is better referred to either as reduplication of the ureters and renal pelves, or better still from the clinical standpoint as double kidney.

* Read before the Chicago Surgical Society, December 1, 1922.

Horseshoe kidney exists in all possible variations of a basic type in which one-half lies on either side of the spine. The two halves of a horseshoe kidney are always connected by an isthmus which varies from a mere narrow band of fibrous tissue or parenchyma to such a wide fusion of the two halves along their mesial borders that one finds simply a single mass in which the separate halves are no longer distinguishable. Although one-half of a horseshoe kidney may be considerably higher than the other and one-half may lie much nearer the median line of the spine than the other half, the two never lie entirely on one side as is the case in crossed ectopia. As will be seen later,

FIG. 2.—Double kidney with no separation of parenchyma and one artery and vein supplying upper half. There is no artery for lower half, only one vein returning blood from this half. (Wimmer, Case 2.)

cases have been described of reduplication of the pelves in horseshoe kidney (Fig. 12), but it is less confusing to term this a combination of horseshoe and double kidney.

By supernumerary kidney we mean a third complete kidney neither connected with the normally placed and developed organ of the side on which it lies nor with the similarly normally placed and developed kidney of the opposite side. Very few recorded cases bear close scrutiny, because some at least are really instances of true double kidney with complete separation of the two halves.

By double kidney then we mean cases in which there is reduplication of the renal pelvis on one or both sides in association with a similar condition of the ureters on one or both sides. Many most excellent contributions like those of Delmas,[1] Mertz[2] and Papin[3] approach this question from a
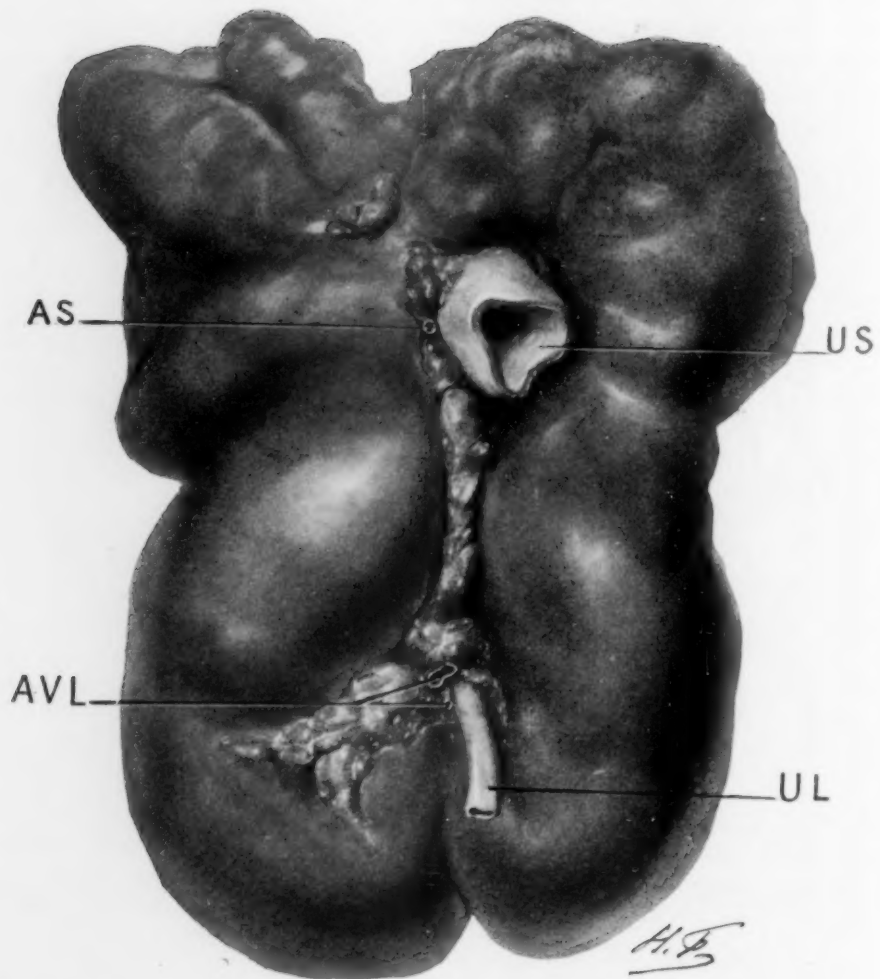
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FIG. 3.—Exterior of double kidney shown in Fig. 4 (Marion). The two halves have a separate blood supply. (See A. S. and A. V. L.) U. S. and U. L.—upper and lower ureters.
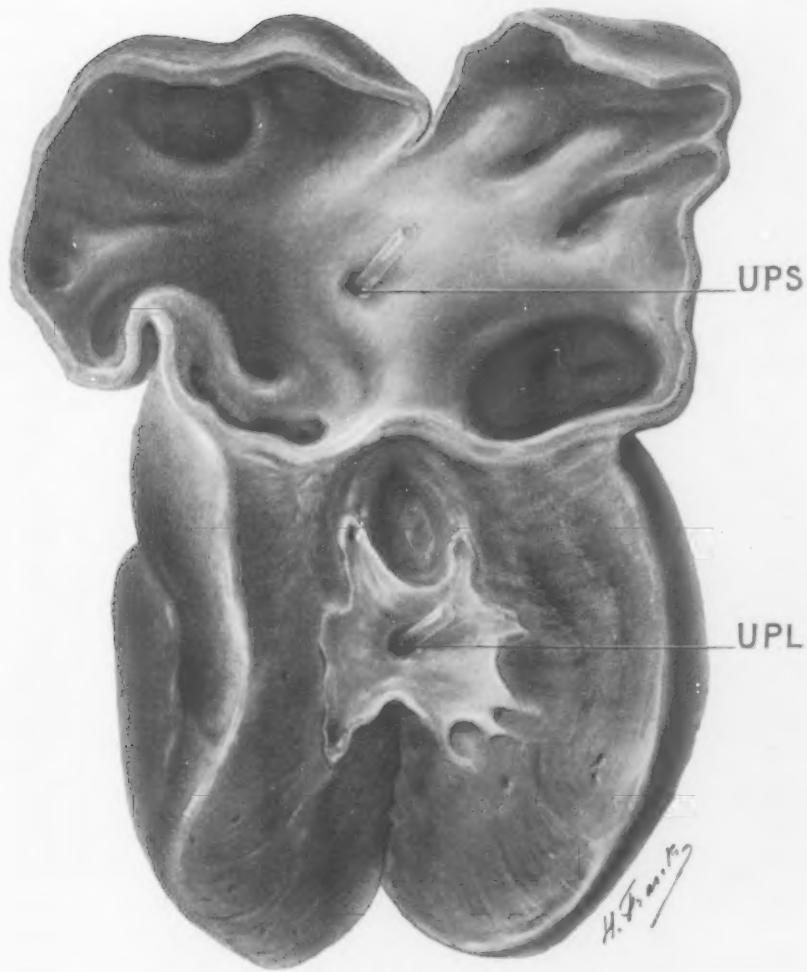
FIG. 4.—Sectional view of case of hydronephrosis of double kidney shown in Fig. 3 (Marion).
Note ease with which the two halves can be separated.

different angle than is the case in this paper. Clinically the reduplication of the ureters (double ureter) is subordinate in importance to the reduplication of the renal pelves (double kidney), because pathological changes in the ureters are, as is true of single ureters, usually secondary to those in the renal pelves and corresponding halves of the parenchyma. For this reason when double kidney is referred to in this paper, it is always understood that there is an accompanying anomaly in the form of a double ureter. Neither Young and Davis[4] nor the writer have been able to find a clinical case in which there was reduplication of the ureters (double ureters) associated with a single renal pelvis, that is, where there were two ureteral orifices on one or both sides, the ureters corresponding to these uniting to form a single ureter and ending in a single renal pelvis.

Frequency.—(a) Frequency in general: Nearly all of the contributions to this subject state the frequency with which reduplication of the ureters is found. There is no recorded case in which there was a reduplication of the ureters and a union at some higher point so as to end in a single pelvis. Hence, the statistics as to relative frequency of reduplication of the ureters
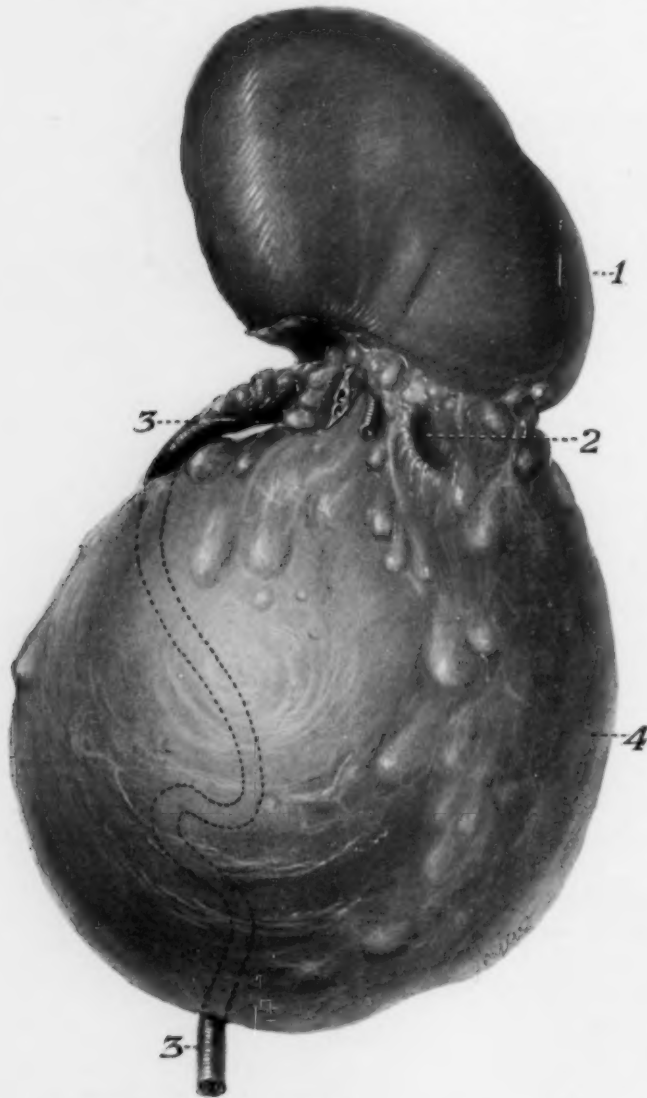
FIG. 5.—Exterior of same kidney shown in Fig. 6 with well marked groove separating the two halves (1 and 4). Note course of ureter (3) from upper half along posterior surface of hydronephrotic lower half. Ureteral (2) opening of lower half was at upper end of dilated pelvis. Blood supply to centre only. (Own case.)
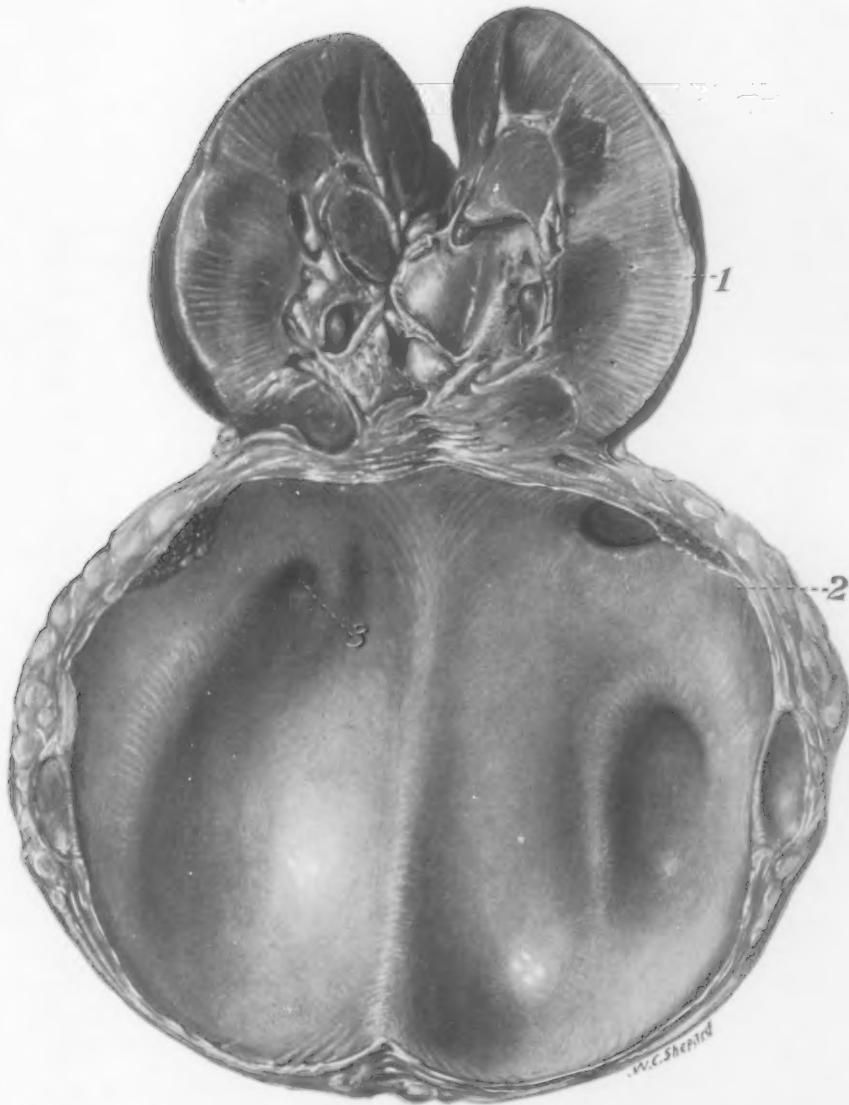
FIG. 6.—Sectional view of kidney shown in Fig. 5. Note normal upper (1) and hydronephrotic lower (2) half. No. 3 indicates location of ureteral orifice at upper portion of sac.

apply equally well to those of reduplication of the renal pelvis (double kidney). The frequency of the latter varies from 1.2 per cent. to 10 per cent. according to different authors; for example, Motzfeld[5] 1.2 per cent. of 972 autopsies, Papin[6] 2 per cent., Bostroem,[7] Pawloff[8] and Hrynteschak,[9] each 3 per cent., Poirier[10] and Shewkuneko[11] 4 per cent., Brewer[12] and Kroiss[13] 5 per cent., Robinson[14] 6 per cent., and finally Weigert[15] 10 per cent. It would seem, therefore, as though the average of 3 to 4 per cent. was a conservative one as to the frequency.

(b) Frequency of the condition on one or both sides: Braasch and Scholl,[16] in a series of 144 cases of reduplication of the ureters and pelves, observed at the Mayo Clinic from 1907 to 1922, found the condition in 135 (94 per cent.) on one side and in 9 (6 per cent.) on both sides. Of the former (unilateral) 36 (25 per cent.) were complete and 99 (68 per cent.) incomplete. Of the 9 bilateral cases 8 (5.5 per cent. of all reduplications) were complete and one (0.7 per cent.) incomplete.

Papin[17] reported 213 cases, that is, 165 (77 per cent.) unilateral and 48 (23 per cent.) bilateral cases. Of the former, 58 (35 per cent.) were incomplete and 107 (65 per cent.) complete. Of the bilateral 12 (25 per cent.) were incomplete and 36 (75 per cent.) complete.

FIG. 7.—Tuberculosis of double kidney, showing complete separation of the two halves. (Marion.)

Mertz[18] reported 276 cases, of which 202 (70 per cent.) were unilateral and 74 (30 per cent.) bilateral. Of the former (unilateral) 62 were incomplete (30 per cent.) and 140 complete (70 per cent.). Of the bilateral 10 (15 per cent.) were incomplete and 5c (84 per cent.) were complete. In 14 cases the anomaly was complete on one side and incomplete on the other.

From these observations of large series of cases one may say that in a total of 619 reduplications of the ureters and renal pelves, the condition was only found on one side in 80 per cent. and on both sides in 20 per cent.

Of 502 cases (80 per cent.) in which the condition was only found on one side, the reduplication was complete in 30 per cent. (156) and incomplete in 70 per cent. (346).

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Of 117 (20 per cent.) cases in which the condition was bilateral, there was complete reduplication in 80 per cent. (94) and incomplete in 20 per cent. (23).

Morphology †.—From the clinical as well as the pathological standpoint we are interested in many features of reduplication of the renal pelvis and
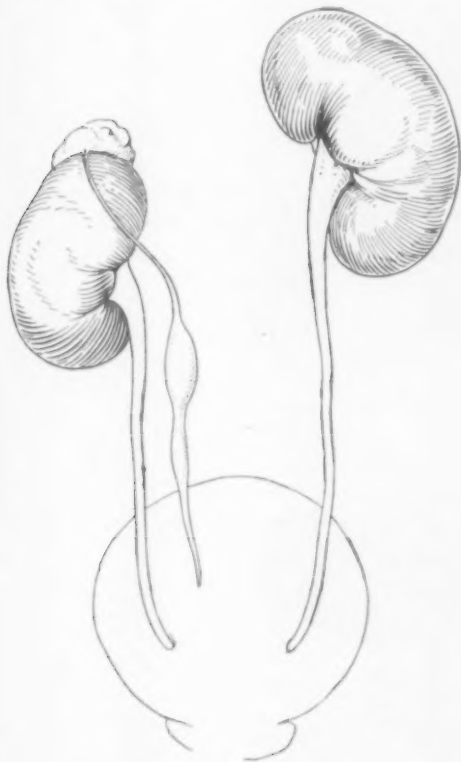

FIG. 8.—Unusual form of double kidney. At upper pole of right kidney is a second accessory kidney whose ureter crosses behind the lower half and ends blindy in wall of bladder. (See Fig. 9.) (Neckarsulmer.)
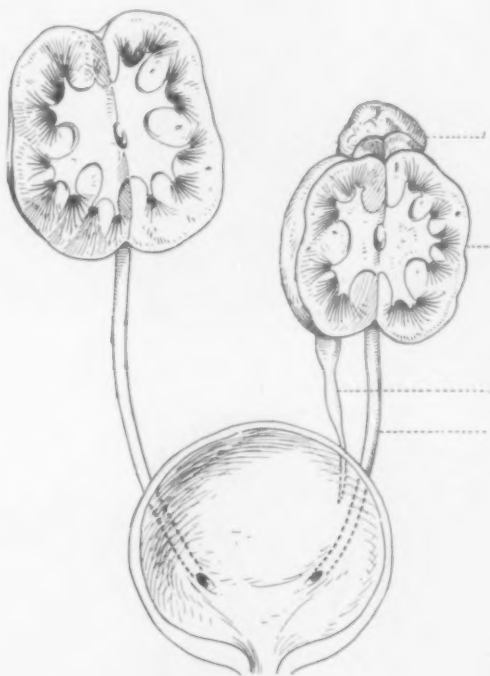
FIG. 9.—Same case shown in Fig. 8. Note how accessory hypoplastic upper half rests on lower half. (Neckarsulmer.)

ureter. For the sake of simplicity one may divide these into those relating to the kidney itself, and into those relating to the ureter.

Kidney.—A. Evidence of separation of the two halves. The following may occur:

(1) Continuity of the parenchyma, that is, absence of any sign of demarcation between the two halves either externally or internally (Figs. 1 and 2). A broad band of parenchyma separates the two pelves internally.

(2) A shallow groove marks the separation of the two halves externally (Fig. 3), and this is often accompanied by a more or less definite separation in the form of a fibrous septum (Fig. 4) internally or of a thin strip of parenchyma.

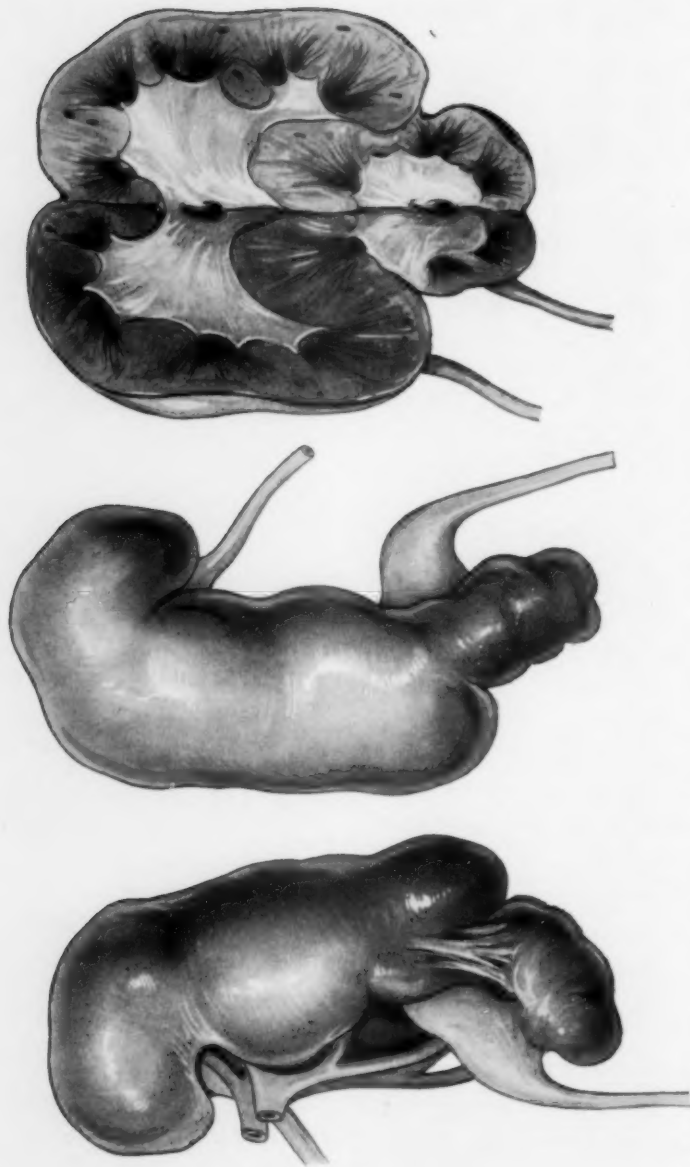† The blood supply will be discussed in connection with technic.

FIG. 10.—Three views of double kidney in which lower half was markedly hypoplastic. Note absence of separation of parenchyma. The ureters united just above bladder. (Wimmer.)

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(3) A deep groove or furrow indicates the area where the two halves join (Fig. 5) and there is a corresponding well-marked separation internally (Fig. 6).

In some of the double kidneys belonging to (2) and (3) the pelves may lie so close together that it is impossible to separate them, especially when both are dilated, that is, hydronephrosis of both halves exists.
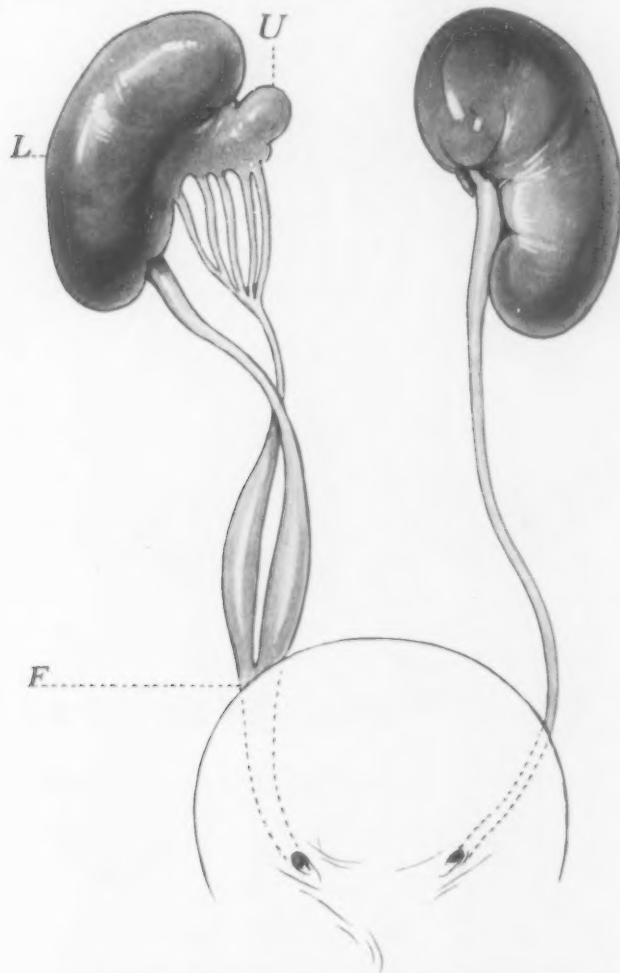

FIG. 11.—Hypoplastic (U) upper half of double kidney, with five primary calyces uniting externally to form ureter without any intermediary renal pelvis. (Fürstner.)

(4) A complete separation of the two halves is found both externally and internally. There is a distinct fibrous band between the two halves (Fig. 7). Such cases might be reported as instances of supernumerary kidney if the two halves are widely apart. The existence of a communication between the two pelves is denied by many but has been found by Braasch and Scholl.[19]

B. Relative size of the two halves.

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As a rule the upper half forms about one-third, and the lower half the remaining two-thirds. The pelvis of the upper half is never as perfectly developed as that of the lower and is always smaller.

A number of cases have been described in which the upper or lower half was so small that they seemed to be mere appendages to the corresponding
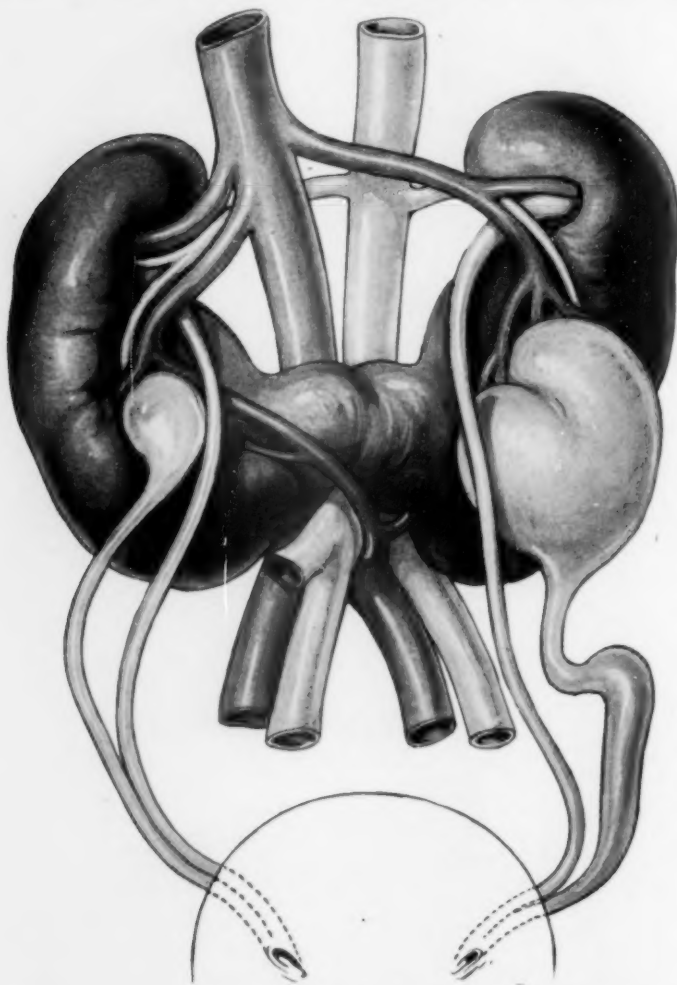

Fig. 12.—Autopsy specimen of horseshoe kidney with bilateral reduplication of the renal pelves and ureters. Note hydronephrotic lower pelves. (Zinner.)

other half. Some authors (Neckarsulmer) have suggested that such a hypoplastic half be called accessory kidney (*Beiniere*), but this distinction would only be confusing. The most typical example of such an extremely small upper half is the case reported by Neckarsulmer.[20] The ureter of this upper half crossed the posterior surface of the lower perfectly formed half (Fig. 8) and ended blindly in the wall of the bladder. On section one can

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see (Fig. 9) the miniature kidney placed cap-like on the upper pole of the lower half. A similar case is reported by Wimmer[21] (Fig. 10) in which the lower half is attached in an appendix-like manner to the perfectly formed upper half.

A curious example of extreme hypoplasia of one-half is the case reported by Fürstner,[22] where the upper half is only partially attached to the lower

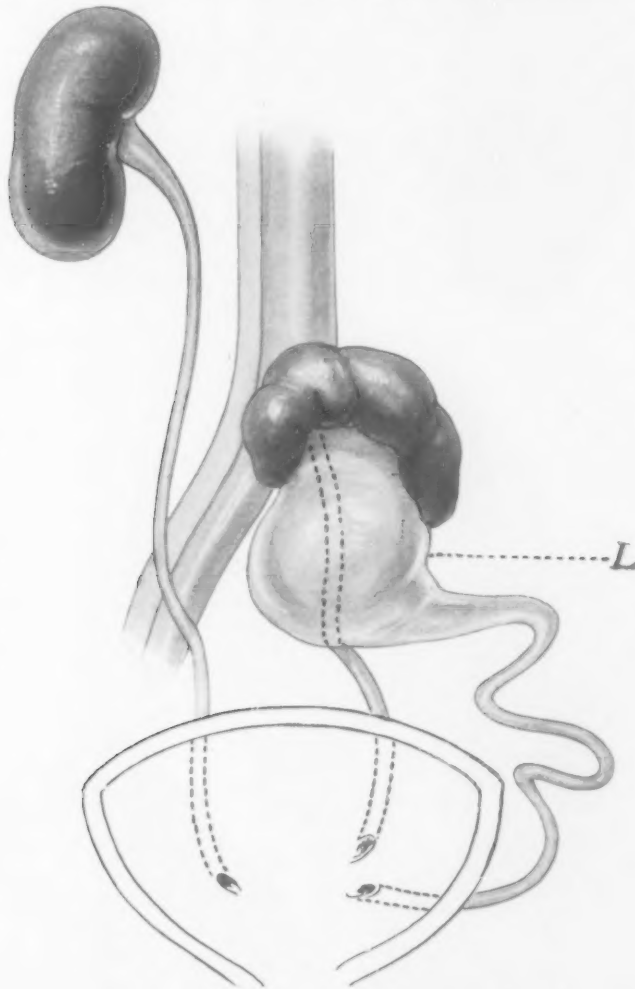FIG. 13.—Ectopic (pelvic) double kidney. (Rumpel.)

half. As frequently occurs in all forms of anomalies of the kidney there is no true pelvis. The ureter arises directly as the result of the union of the primary calyces (Fig. 11).

C. Double kidney may be associated with other anomalies.

One frequently sees a combination of one form of renal anomaly with that of an entirely different group.

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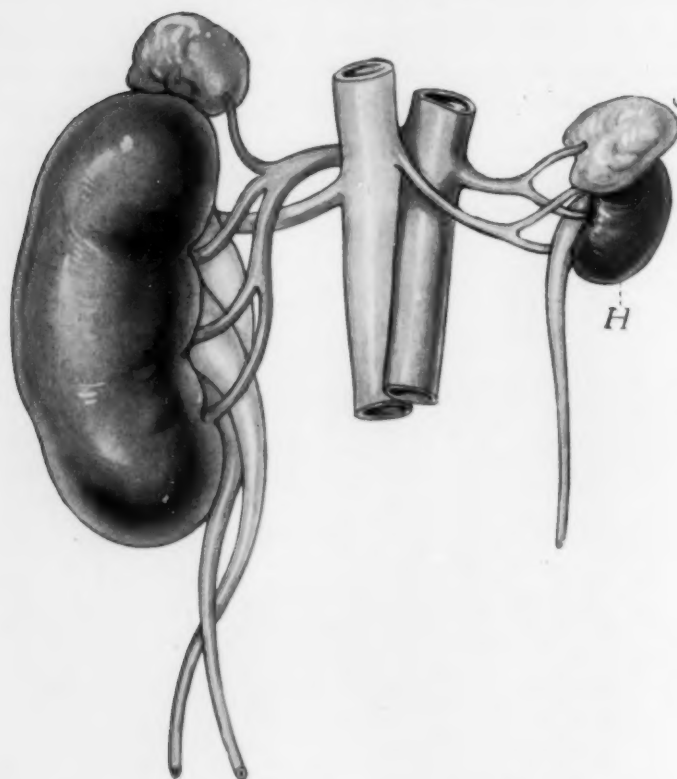
FIG. 14.—Right double and left hypoplastic kidneys. Left kidney size of adrenal with single ureter which ended normally. On right side large double kidney whose ureters ended one above the other at right angle of trigone. A single renal artery supplied both halves of the double kidney. (Gruber and Bing.)
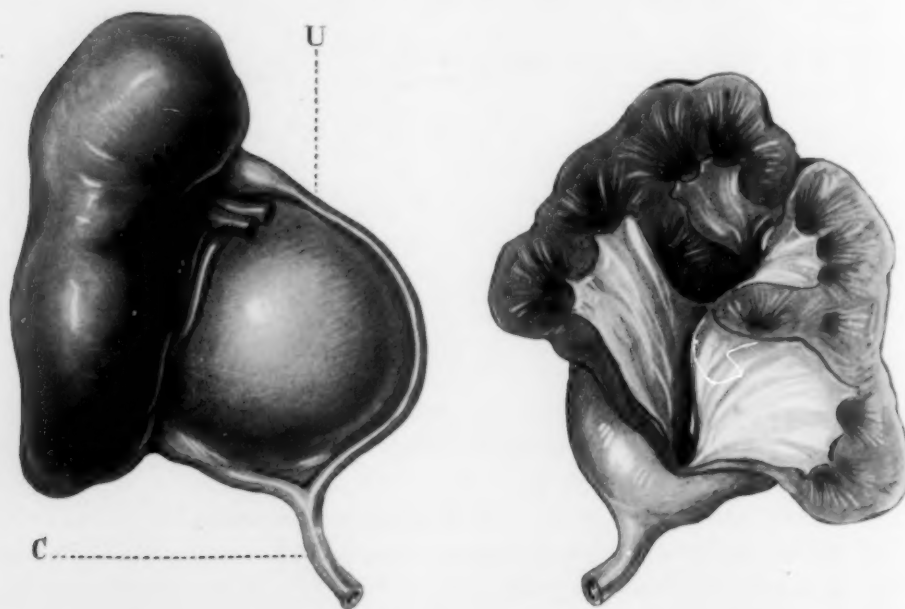
FIG. 15.—Specimen showing relation of the two ureters at renal hilus. Ureter from upper half (U) passes along mesial border of dilated pelvis of lower half to unite with ureter from lower half to form common ureter (C). (Wimmer.)
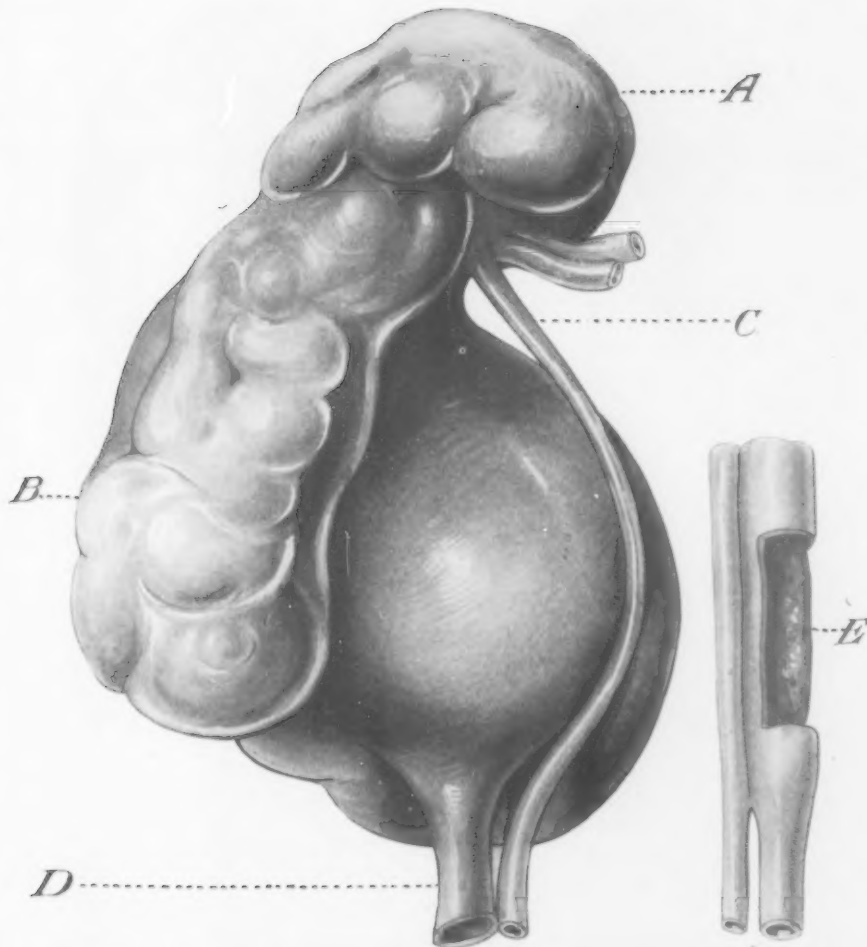
FIG. 16.—Pyonephrosis of lower half of double kidney due to calculus (E). Ureter of upper half (C) passed across pelvis of lower half. (Kusnetzky.) A. Upper half normal. B. Lower pyonephrotic half. C. Ureter of upper half. D. Ureter of lower half. E. Calculus blocking lower ureter. The two ureters united in bladder wall.
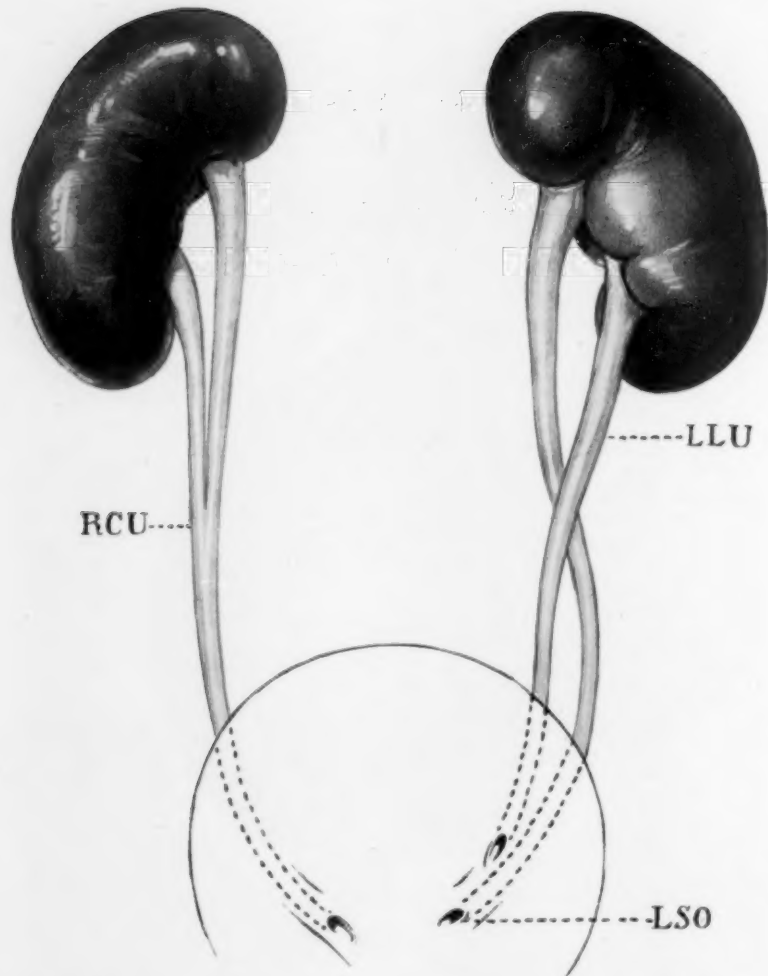
FIG. 17.—Bilateral double kidney. (Weigert.) On right side the two ureters unite at pelvic brim. On the left side the ureter from the lower half (LLU) ends at normal location, while that from upper half ends lower and more mesial (LSO).

Several instances have been reported in which each half of a horseshoe kidney had two ureters and two renal pelves. In Zinner's [23] case (Fig. 12) both lower pelves were dilated.

The double kidney usually lies a little lower than normal, but as in Rumpel's [24] case (Fig. 13), it may lie in the true pelvis and be mistaken for an ectopic kidney without reduplication of the ureters and pelves.

A most instructive case has been observed at autopsy by Gruber and Bing.[25] There was a typical double kidney (without external separation) on the right side and a hypoplastic kidney on the opposite side (Fig. 14).

Ureter.—*A.* Relation of the two ureters to each other at upper end and to the renal pelves.

This is of much importance from the surgical standpoint.

Each renal pelvis as a rule ends in a ureter, but as stated above there may be no true pelvis, only a number of calyces which unite to form the ureter (Fig. 11).

The distance between the two ureters at the hilus depends: (*a*) upon the relative size of each half, and (*b*) whether or not one pelvis or an entire half is enlarged as the result of a hydronephrosis, etc. Figure 5 from one of my own cases shows how the ureter of the upper half passed downward along the posterior surface of the lower hydronephrotic half and could be easily overlooked at operation.

The ureter of the upper half may lie throughout its course in the most intimate relation (Figs. 15 and 16) with

Fig. 18.—Pyonephrosis of upper half of double kidney. Stenosis of lower end of ureter from upper half. (Tschudy.)

the greatly dilated pelvis of the lower half and be difficult, if not impossible, to separate. Both ureters may lie in the same sheath along their entire course from the hilus downwards so that the presence of a reduplication may be overlooked unless such a diagnosis has been made before operation or a well-marked groove exists externally in the kidney proper.

Some cases have been reported as double kidney which are in reality examples of bifid renal pelvis, that is, where two large primary calyces unite either intra- or extra-renally to form the ureter.

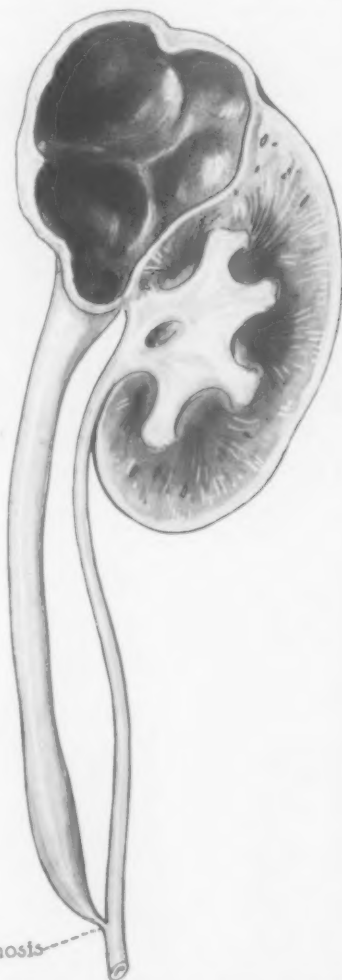*B.* Level of union, mode of crossing and of normal ending of ureters.

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The two ureters may unite at any level from a point just external to the hilus to one within the bladder wall. As a rule each ureter possesses its own sheath up to the point of union, but at times, as in a case recently reported by Schoonover,[26] the two ureters have a sheath in common so that separation is impossible. Even in cases of complete reduplication, the two ureters may

FIG. 19.—Most frequent location of ureteral orifices in double kidney. A. Both at same level. B. One above the other. Mesial and lower as a rule leads to upper half. (Bætzner.)
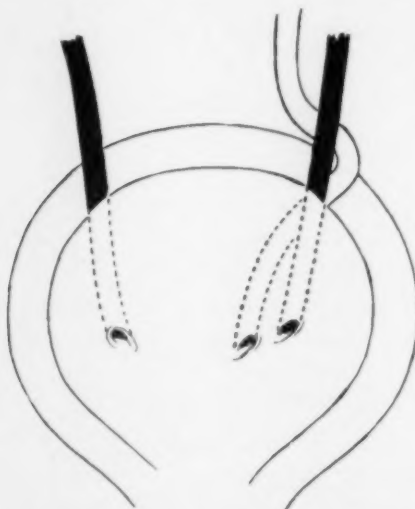
FIG. 20.—Case illustrating crossing of ureters close to or within bladder so that the ureter from upper half ends mesial and caudal to that from lower half. (Wimmer.)

be enclosed in a common sheath at their lower end, especially just above and within the bladder wall.

Of great interest from the clinical standpoint are the observations (a) that a stenosis of one ureter has been found where the two ureters unite (Fig. 18) and (b) that a communication may exist between the ureters as observed by Handl,[27] Klose,[28] Unterberg,[29] Seelig[30] and Wimmer[31] (Fig. 29).
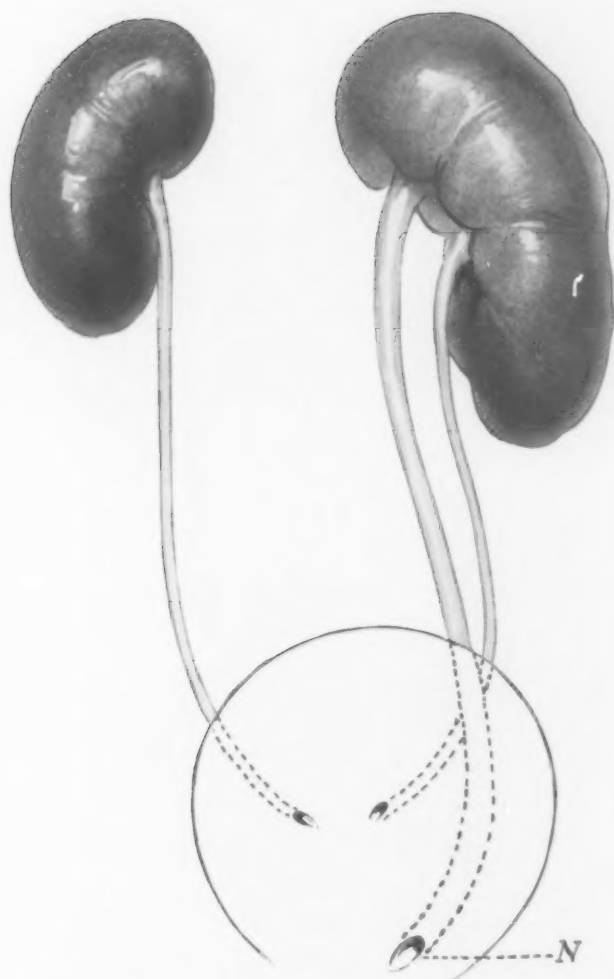
FIG. 21.—Double kidney (left) with ureter from upper half ending at neck of bladder (N).   (Wrany.)

FIG. 22.—Ureter (1) of upper half of right double kidney ends in prostatic urethra (2). (Weigert.)
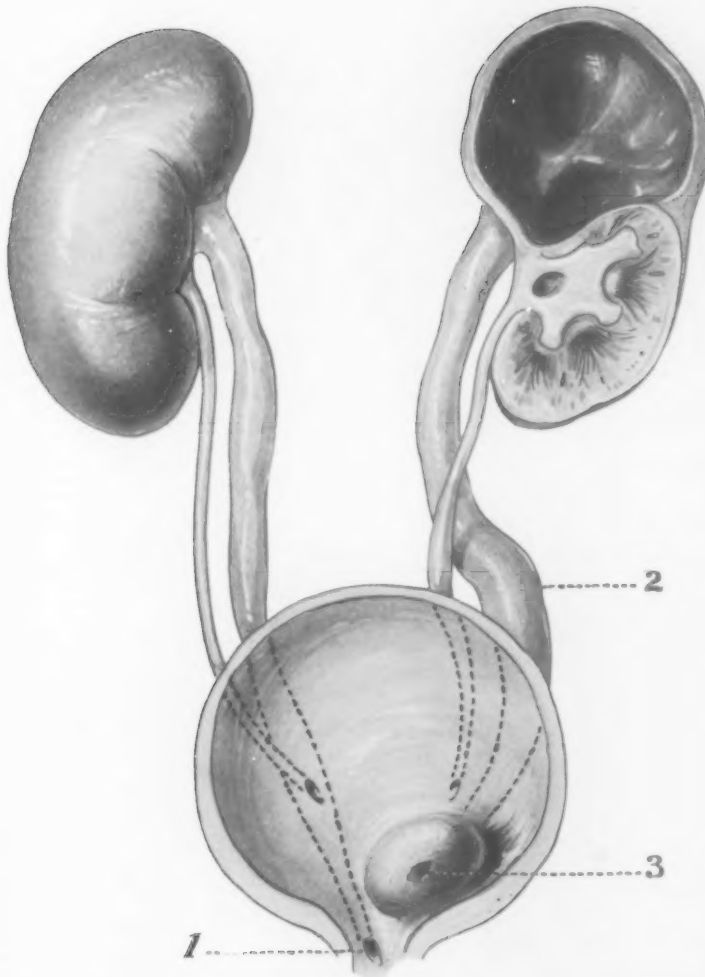
FIG. 23.—Bilateral double kidney. The dilated ureter from upper half of right kidney ends (1) at neck of bladder. On the left side the upper half was hydronephrotic. Its ureter (2) ended in a (3) cystic dilatation below the other ureter of same side. (Reinfelder.)

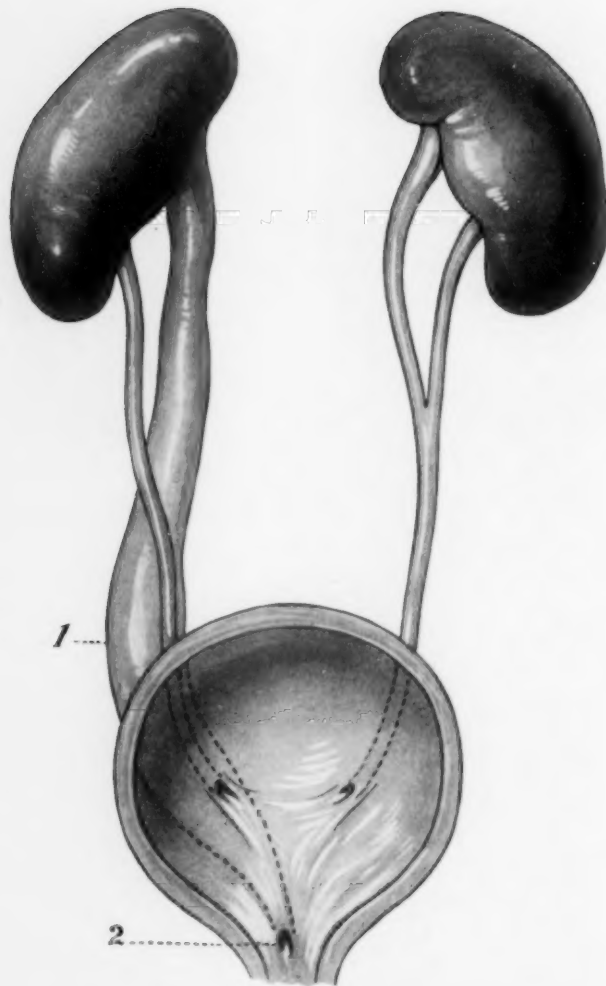In Handl's case there was a slit-like communication where the two ureters crossed before entering the bladder wall. In Wimmer's case there was a broader communication in the intramural portion of the course of the two ureters.

The question of how the two ureters cross each other has been the subject of much discussion by a number of those interested in the subject.

FIG. 24.—Bilateral double kidney. On left side ureters unite in wall of bladder. On right side ureters are both dilated. Ureter of upper half (right) ends in cystic dilatation which obstructed internal meatus. (Boström.)

The ureters never cross beyond the midline of the spine. Robert Meyer,[32] whose autopsy studies corroborated to a great extent those of Weigert,[33] states that the crossing of the ureters varies greatly and that they may not cross at all. When they do cross, it always occurs at two places in the same plane. Of the two adjacent ureters the mesial ureter always belongs to the upper half.

A rule to which there are few exceptions is that the final crossing (Fig. 20) of the ureters always takes place in such a manner that the ureter

belonging to the upper half crosses to the inner (mesial) side of the ureter belonging to the lower half, so that the former (ureter from upper half) ends mesial and more caudal (nearer bladder neck) than that from the lower half. There is no authentic case where the ureter from the upper half opened cranial to that from the other ureter.

In the bladder the two ureteral orifices as a rule either (a) lie one above the other (Fig. 19), the lower and more mesial being that of the ureter of the upper half, or (b) they lie closer together, the mesial and more caudal (Fig. 19) again belonging to the ureter of the upper half.

C. Ectopic or abnormal mode of ending of the ureters.

The only available statistics in regard to the frequency with which this occurs in double kidney are those of Mertz,[34] 42 (30 per cent.) of 140 complete reduplications, and of Braasch and Scholl,[35] 3 (12 per cent.) of 36 complete reduplications. The abnormal modes of endings of one or both ureters do not differ from those which may occur in the case of a single kidney on one or both sides of the body. The ureter from the upper half is usually the one which ends abnormally if only one ureter is involved.

The most frequent of the ectopic forms of ending are:

1. At neck of bladder (Figs. 21 and 23) in usual form of orifice.

FIG. 25.—Both ureters end in a common cystic dilatation. Upper half of double kidney markedly hypoplastic. (Rendu.)

2. In prostatic urethra (Fig. 22) in usual form of orifice.

3. One ureter ends in a cystic dilatation on the surface of which there may (Fig. 23) or may not (Fig. 24) be a small ureteral orifice. In one of Boström's[36] cases such a cystic dilatation blocked the internal meatus and resulted in an obstruction to both ureters of the double kidney (Fig. 24).

4. Both ureters end in cystic dilatation and communicate within the sac (Fig. 25).

5. One ureter may end blindly above or below or both (Fig. 26), the lower blind end dilating as in Clairmont's[37] case, containing calculi and forming a protrusion in the midline of the bladder.

6. One ureter ends in the seminal vesicle of the same side as that upon which the double kidney is located. A typical case of this type of opening into the male genital tract was reported by Hoffmann[35] (Fig. 27).

FIG. 26.—Double ureter (left). The second ureter ends blindly above and below. Its lower end greatly dilated and filled with calculi. A few calculi also found in middle portion of the accessory ureter. (Clairmont.)
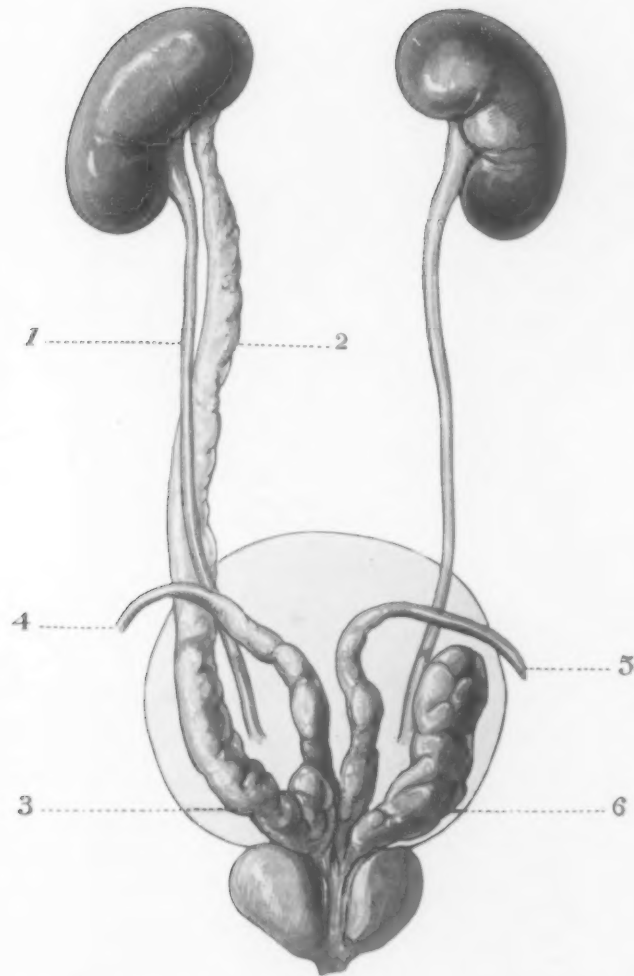
FIG. 27.—Ureter (1) of upper half of right double kidney ends in seminal vesicle of same side (3.) Ureter (2) of lower half ends normally. (4) Dilated right vas deferens. (5) Left vas, and (6), seminal vesicle. (Hoffman.)

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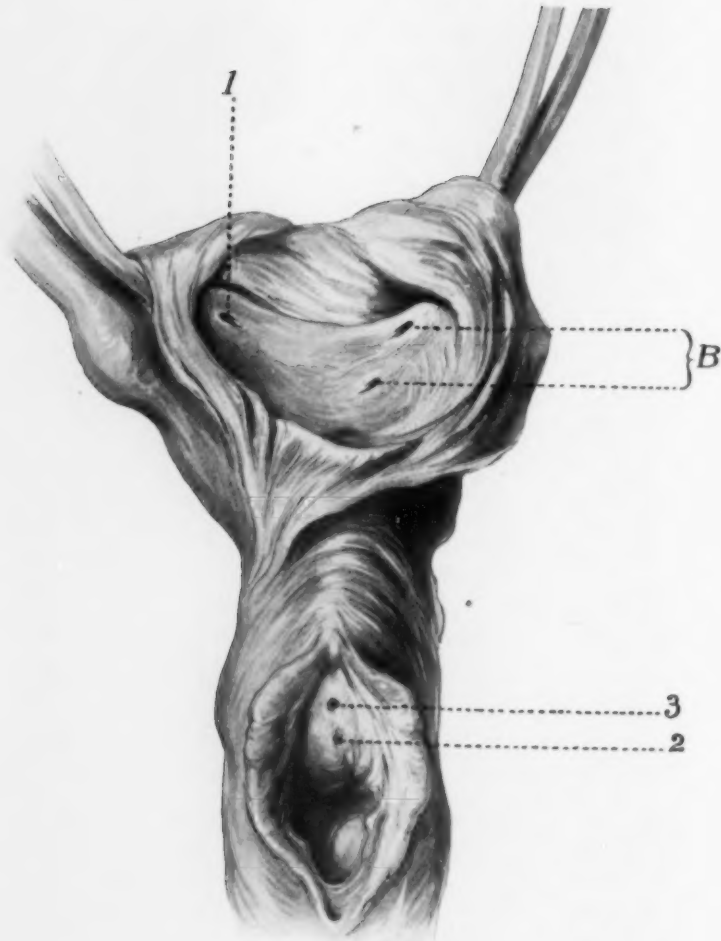
FIG. 28.—Bladder, lower portion of ureters and external genitalia from case of bilateral double kidney. On left side both ureters ended in bladder (B), while on the right side, one ureter ended (1) normally and the other (2) ended just below external (3) meatus. (Bætzner.)

7. Endings, either blind or by open ureteral orifice in the female genital tract: (*a*) urethra, (*b*) vagina, (*c*) vestibule—usually in the latter, below or lateral to the external meatus (Fig. 28). This will be referred to under the clinical aspects as one of the causes of incontinence of urine to be looked for in females.

Schwartz's [39] classification of abnormal ureteral endings is applicable to-day in spite of more advanced methods of diagnosis and is worthy of quoting at this point.

I. Open endings into male genito-urinary tract.

    (*a*) Into bladder (usually near neck) (Fig. 21).

    (*b*) Into urethra (Fig. 22).

    (*c*) Into seminal vesicle, ejaculatory duct and vas deferens (Fig. 27).

II. Open endings into female genito-urinary tract.

    (*a*) Into urethra.

    (*b*) Into vagina.

    (*c*) Into vestibulum vaginæ (Fig. 28).

    (*d*) Into persisting duct of Gaertner.

III. Blind openings.

    (*a*) Into muscular layer of bladder.

    (*b*) Into submucous layer (Fig. 26) of posterior wall or floor of bladder.

    (*c*) Into a cystic dilatation (Figs. 23, 24 and 25).

    (*d*) Into submucous tissue of vagina or vestibule.

D. Associated defects of the male and female genitalia.

These are far more frequent in cases of solitary or hypoplastic kidney and in crossed ectopia than in either double or horseshoe kidney

<p style="text-align:center">(To be continued.)</p>

FIG. 29.—Bilateral double kidney. The two ureters of each side communicated in wall of bladder. (Wimmer.)

SARCOMA OF THE UTERUS

By Philip J. Reel, M.D.

AND

Paul H. Charlton, M.D.

of Columbus, Ohio

FROM THE DEPARTMENT OF PATHOLOGY, OHIO STATE UNIVERSITY

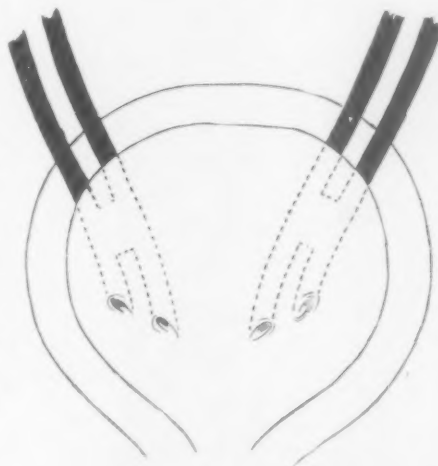WHILE English observers at a very early period recognized that certain uterine tumors of a benign character recurred after operation, it remained for Virchow, in 1860, to first describe the gross and histologic pictures in a series of uterine sarcomata and particularly sarcomatous changes occurring in uterine myomata. Following this description these tumors have been discussed by many authors. In 1872, Chrobak directed attention to this type of neoplasm and in 1887, Ritter gave a review of the literature to that date.

FIG. 1.—Case No. 19705. Gross photograph of sarcoma of the uterus which presented marked parauterine invasion, with the absence of fibromata. There was marked invasion of the broad ligament with no invasion of the uterine cavity, which is not seen in the photo.

Williams and Schreber, in 1895, gave a full discussion of the histology and histogenesis of these tumors. In 1889, Gessner published a most exhaustive study of sarcoma of the uterus. Since that time this tumor has been widely discussed principally by foreign writers. A review of this literature discloses the fact that while much, particularly of the later writings, have been upon the clinical aspects of this neoplasm, very little has been offered as an addition to our knowledge of its histology and histogenesis except in a recent study by Evans at the Mayo Clinic, in 1920. He concludes that the presence of large numbers of mitotic figures is "the only single constant microscopic evidence of definite malignancy."

While this type of tumor is said to form less than 0.5 per cent. of all malignant growths of the uterus, our observations would lead us to believe that it occurs much more frequently than the literature, especially the American, would seem to indicate. We have been able to collect nine cases of sarcoma of the uterus from a series of two hundred and eighty-eight (288) uteri sent to the laboratory of the Department of Pathology of Ohio State University for routine examination. In addition there were two cases sent to the laboratory from other clinics, making the total of eleven (11) sarcomata in two hundred and ninety (290) cases studied. Of this number, one hundred and four (104) uteri were removed with the clinical diagnosis of uterine fibroids. Some of these cases are frank primary sarcoma of the

FIG. 2.—Case No. 19705. High power photomicrograph showing connective tissue undergoing hyaline degeneration.
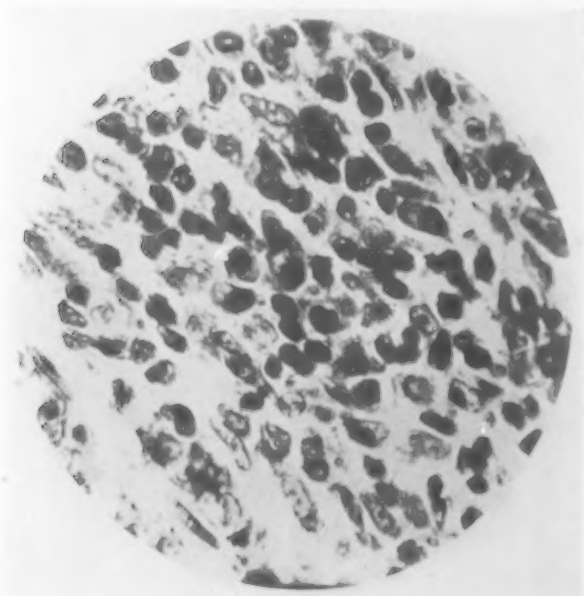

FIG. 3.—Case No. 19705. High power photomicrograph showing the gradual invasion of muscle by sarcomatous cells.

uterus, while others represent a sarcomatous change occurring, apparently, in preëxisting fibroids or as coexisting growths. With these facts in mind we believe a discussion of this type of neoplasm to be of extreme importance, and of sufficient gravity, to merit the study we have given it as well as to endeavor to interest the profession in this class of cases. It is evident that an accurate microscopic diagnosis is essential to establish, even to a limited degree, the further treatment necessary, as well as the prognosis.

While most authorities are in agreement as to the classification, clinical aspects, and treatment of this tumor, the question as to its histogenesis has remained an open one. It is generally conceded by most authors that from 1.5 per cent. to 2.5 per cent. of fibroids show sarcomatous change. A resumé of the uteri examined in this laboratory would not tend to bear out the foregoing figures, in that we were able to find nine sarcomata in a total of one hundred and four (104) uteri removed because of a diagnosis of fibroids, making the percentage of occurrence in our series 8.6 per cent.

FIG. 4.—Case No. 19705. High power photomicrograph showing sarcomatous area and the presence of mitotic figures.

With this high percentage of occurrence it may be readily seen that it becomes necessary to make a careful gross examination of all fibroid masses found in these uteri and in addition a careful microscopical study of all areas in which suspicion is aroused, as evidenced by softening, change in color, decoloration, or fusion of the capsule and the surrounding tissue.

As a working classification, that suggested by Ewing would seem to be most satisfactory, namely, that sarcomata originate in the wall of the uterus or in the endometrium. The greater percentage of sarcomata undoubtedly arise in the wall, and this fact is borne out in our series of cases. Most authors, at the present time, agree that fibroid tumors may undergo sarcomatous change. It is difficult, at times, to decide whether the sarcoma has been such since its origin, or whether it has resulted from a malignant transformation arising within the preëxisting myoma. Several of our tumors presented nothing but sarcomatous cells. These have occurred as single tumor growths with a marked tendency to encroach upon the uterine cavity

and seem to arise from the periglandular stroma. This type of tumor seldom, if ever, shows a tendency toward true encapsulation but rather tends toward a circumscribed mass, the edges of which fade rapidly into the uterine tissue without the formation of a distinct capsule. The portion of the growth which projects into the uterine cavity is covered by a mucous membrane which is usually atrophic and may show areas of necrosis, but still remains continuous with the remainder of the endometrium. This tendency toward necrosis may account for the more or less continuous type of hemorrhage encountered clinically in such cases.

A histologic examination of sections removed from many different areas of the tumors of our series would lead us to agree with Eden and Lockyear that in most cases the sarcoma cells arise from a metaplasia of the connective-tissue cells of the fibroid. In addition our series substantiates the observations of other writers, namely, that the spindle-cell type of tumor originates in the musculature of the uterus and the cells tend to differentiate as smooth muscle cells. It is possible that they may arise simultaneously from both sources, even in the same tumor. The fact that they may have a myogenic origin does not lead us to believe that the change has arisen from a malignant leiomyoma which we recognize as an exceedingly rare type of tumor, which in the majority of cases, can only be diagnosed by the presence of metastasis, elsewhere in the body. While it is evident that

FIG. 5.—Case No. 20655. Gross photograph of endometrial type of sarcoma showing protrusion of the mass into uterine cavity, the margins of the mass being continuous with the uterine mucosa.

the histogenesis of these tumors may be only of academic interest, the histopathology plays an important part in that, not infrequently, they are diagnosed clinically and at times, even at operation, as benign uterine tumors, except when they present an advanced stage of malignancy, as evidenced by softening, infiltration and fixation of the masses.

Of the eleven cases forming the basis of this paper, nine presented grossly the picture of definite multiple fibroids. The gross section of these revealed in the majority of instances an area of apparent sarcomatous change enclosed within one of the fibroid masses. It was not uncommon to find a multinodular uterus with but one nodule showing sarcomatous transformation. This would tend to strengthen the contention that a sarcoma may arise in a preëxisting fibroid.

One of the remaining two was found to be a distinct globular mass, protruding into and occupying most of the cavity of the uterus. The consistency of this tumor was soft, friable, and upon gross section presented the typical yellowish color which seems to be characteristic of the endometrial

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or mucosal type of sarcoma. The remaining specimen presented a diffuse growth involving the anterior and lateral walls of the uterus, with a marked invasion of the peri-uterine structures, and was of the above-mentioned yellowish hue.

The tendency toward interstitial extravasation and actual hemorrhage should draw particular attention to fibroid masses which contain areas of softening. This condition is seldom found in uncomplicated fibroids. The increased vascularity attendant upon malignant change apparently explains the presence of hemorrhage, which is rather prevalent in these sarcomatous areas. While softening and necrosis may take place in the nonmalignant tumor, we seldom if ever encounter within the substance of the fibroid, blood-vessels of sufficient size to produce such hemorrhage unless it is directly associated with those vessels found within the capsule. While the presence of blood in some form should not serve as a criterion upon which to make a gross diagnosis of sarcoma, inasmuch as the same condition may be encountered in those tumors which contain an increased cellularity, it

FIG. 6.—Case No. 20655. Low power photomicrograph taken at the junction of the uterine mucosa with the mass, showing the atrophy of the glandular elements.

should arouse suspicion and demand microscopical examination.

Under the microscope, sarcoma of the uterus may present many different varieties of cellularity. In those uteri which present distinct fibroid masses, we may find in some instances a rather marked line of transformation from typical fibroid connective tissue into that of a very cellular sarcomatous structure. On the other hand, the sarcomatous change may gradually merge into the benign connective tissue and present throughout this region areas which if seen by themselves would be impossible of a diagnosis of anything other than an increased cellularity. Blocks removed from the somewhat more softened portion of the tumor wall show the typical sarcomatous arrangement, presenting very little if any adult connective tissue and the presence of well-developed round and spindle-shaped cells associated with a rather abundant blood supply. Areas of hemorrhage are also frequently found which may account for the gross softening often seen in these cases. The

presence of mitotic figures is not infrequent, and when not found in these tumors which tend to remain myomatous, can be considered as a definite aid in making a differentiation from sarcoma. It is necessary, however, to carefully examine the section and not overlook the possibility of a soft fibroid showing mitosis, being a malignant leiomyoma. Careful study of the cell morphology as well as the history of the case, especially with reference to metastasis, should make this differentiation possible.

A microscopical study of the two cases which we have considered as coming under the classification of endometrial or mucosal origin would lead us to believe that the sarcomatous cells arise in the periglandular connective tissue, bearing in mind the fact, that the uterus, in the true sense, has no submucosa—the glands extending into the muscularis. This marked cellularity which is the predominant microscopical finding in this type of sarcoma would seem to explain the friability of the tumor and the early tendency toward hemorrhage which in some instances may be mistaken for the hyperplastic type of endometritis. This fact should
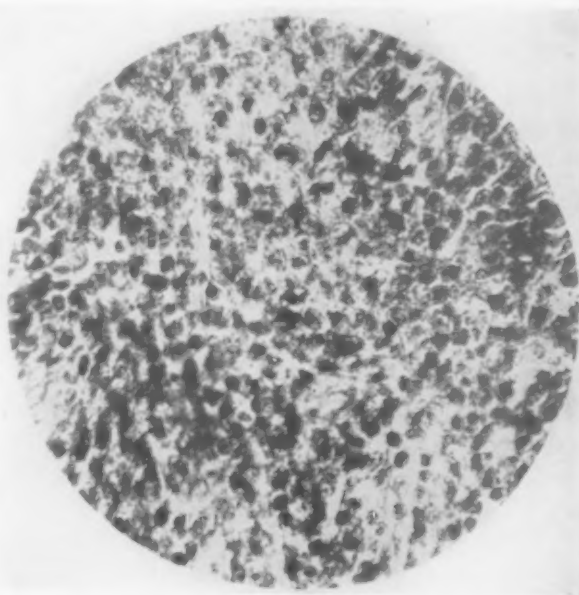
FIG. 7.—Case No. 20655. Low power photomicrograph showing marked cellularity of this tumor.

emphasize the importance of microscopical examination in those cases of hyperplastic endometritis subjected to curettage as a means of treatment. Microscopically, the type of cells composing this class of tumor are ovoid or round, very abundant, with little or no tendency toward adult cell differentiation, and usually show many mitotic figures.

SUMMARY

We desire to emphasize the importance of a very careful microscopical study of all suspicious areas found in uteri removed where the clinical diagnosis is one of multiple fibroids. Even though the gross appearance of many uterine fibroids may be typical of the benign type of tumor, we have found upon routine sectioning areas which appear suspicious and that malignant change occurs in a much higher percentage of incidence (8.6 per cent. in our series) than we have heretofore been led to believe.

FIG. 8.—Case No. 21667. Gross photograph. Multiple fibroid of the uterus showing an area of sarcomatous change in one of the fibroid masses.
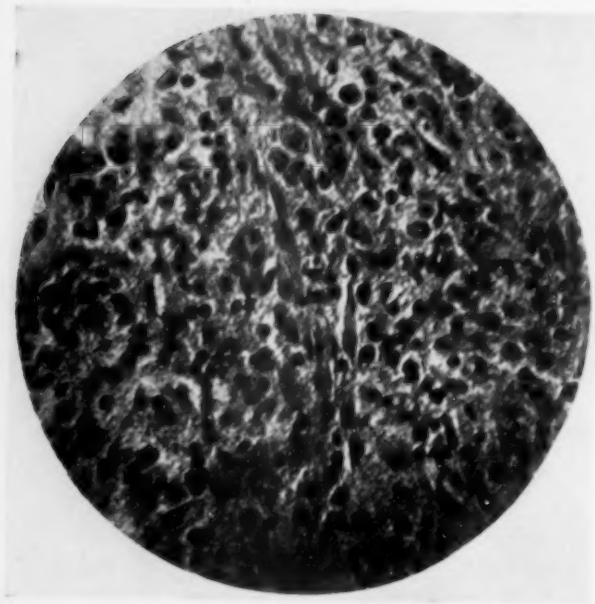
FIG. 9.—Case No. 21667. Low power photomicrograph of sarcomatous area. shown in figure 8.

It would seem that the connective tissue of a fibroid plays an important part in the histogenesis of sarcoma of the uterus. The endometrial type arising in the periglandular tissue of the stroma is the most malignant type of sarcoma of the uterus encountered.

BIBLIOGRAPHY

Aubert and E. Casse: Marseille-Medical, vol. lvi, pp. 1126–1128, Dec. 15, 1919.

Andrews, H. R.: Proceedings Royal Society Medicine, Aug., 1921, vol. xiv, No. 10, p. 324.

Beclere, A.: J. de Radiol et d'Electrologia, vol. iv, pp. 529–536, 1920.

Begouin: Revue de Gynecologie, t. vol. xix, p. 279.

Berard: La Prov. Méd., 2 mai, 1896, no. 18 (Cite dans Piquand, Thèse de Paris, 1905).

Bradly, Leo: Johns Hopkins Hosp. Bull., vol. xix, pp. 164–165, 1918.

Busse: Deutsche medizinische Wochenschrift, 1904, no. 10.

Chrobak: Arch. f. Gynak., vol. iv, 1872.

Costes: Recherches anatomo-pathologiques, sur l'evolution des fibro-myomes de l'uterus et de ses annexes. These de Paris, 1895.

Devic et Gallavardin: Contribution a l'etude du myome malin. Revue de Chirurgie, t. vol. xxiv, 1901.

Dudley: Principles and Practice of Gynecology, p. 422.

Eden and Lockyear: Gynecology for Students and Practitioners, p. 510.

Evans, Newton: Surg., Gyn. Ob., vol. xxx, No. 3, p. 225.

Ewing: Neoplastic Diseases, 2nd Ed., pp. 203–217, pp. 263–268.

Forgue et Massabuau: Gynecologie.

Frankie: dans Liepmann, Lehrbuch des Frauenheilkunde.

Gessner: Feits Handbuch der Gynækologie, 1899, vol. iii, 2nd half, p. 957.

Glanteney et Marie: Bulletins de la Societe anatomique de Paris, 1898, p. 291.

Hedley, J. P.: Proceedings Roy. Soc. Med., vol. x, pp. 81–82, May, 1917 (Sect. Obst. and Gyn.).

Hellier, John B.: Clinical Journal, vol. xliv, pp. 417–422, Dec. 29, 1915.

Jacquin, P.: Gynec. et Obst. Par., vol. iii, pp. 91–111, 1921.

Jacobi, Mary P., and Wollstein, Martha: Amer. Jour. Obst., 1902, vol. xlx, p. 218.

Krische: Inaugural Dissertation, Gottinger, 1889.

Langerhans: Berliner klin. Wochenschrift, 1893, no. 14, p. 338.

MacCallum: A Text-book of Pathology, p. 968.

Menetrier: Le cancer (Traité de Médecine, Brouardel, Gilbert, Thoinet).

Morris, Roger S., and Wooley, Paul G.: Lancet-Clinic, pp. 116–164–165, August 12, 1916.

Meyer, R.: Dans Veit's Handbuch der Gynakologie, t. vol. i, p. 443. (Edition de 1908.)

Minkowsky: Munchener med. Wochenschrift, 1901, no. 33.

Paviot et Benard: Archives des Médecine experimentale, t. vol. ix, 1897.

Pick, L.: Archiv. v. Gynak., 1895, vol. xlviii, p. 24, und vol. xliv, p. 1.

Piquand: Revue de Gynecologie, 1905.

Piquand: Thèse de Paris, 1905.

Ribbert: Geschwulstlehere.

Ritter: Inaugural Dissertation, Berlin, 1887.

Robin: Thèse de Bordeaux, 1912.

Schlagenhaufen: Weiner klin. Wochenschrift, 1902, no. 20.

Schottlander Kermauner: Das Uteruscarcinoma, p. l, ix–x, no. 43.

Schreher: Inaugural Dissertation, Jena, 1894.

Solomons, B.: Tr. Roy. Acad. Med. in Ireland, vol. xxxiii, pp. 328–329, 1915.

Theododoroff: These de Montpellier, 1899.

Thornton, John T.: West Va. Med. Jour., vol. iii, pp. 395–399, 1908–1909.

Ulesco Stroganova: Monatsschrift, f. Geb. und Gyn., 1903, t. vol. xviii, p. 357

Veit: Handbuch der Gynekologie (Ed. de 1907–1908).

Vigues: Progrès de Médicale, 1921, vol. xxxvi, p. 289.

Virchow: Die Krankhaften Geschwulste, vol. iii, p. 201.

V. Franke: Festchrift fur Rindfleisch. (Leipzig, 1907).

Warner, Frank: American Journal Obst., 1917, vol. lxxv, p. 241.

Whitridge Williams: Prager Zeitschrift t. Heilkunde, 1894, t. vol. xv.

Wier, William H.: Amer. Jour. Obst., 1901, vol. xliii, p. 618.

Williams, J. Whitridge: Amer. Jour. Obst., 1894, vol. xxiv, no. 6.

SEPARATION OF THE UPPER EPIPHYSIS OF THE TIBIA

By Alexander Gibson, M.B., F.R.C.S., Eng.

of Winnipeg, Canada.

Diastasis, or epiphyseal separation, is an accident that is possible only in adolescent life or late childhood. It is rare before the age of twelve. According to Kirmisson, in a large majority of cases it is the result of indirect violence. The epiphyseal cartilage usually remains attached to the epiphysis, though this is probably not an invariable rule. The injury is frequently accompanied by extensive stripping of periosteum. It is stated that there is no epiphysis in the body which may not be detached as the result of injury. Much the most frequent sites of epiphyseal separation are the lower epiphysis of the radius and the upper epiphysis of the humerus. It is rather surprising that while detachment of the lower femoral epiphysis is comparatively common, and partial detachment of the tongue-shaped process of the upper tibial epiphysis is also common (Osgood-Schlatter disease), separation of the upper epiphysis of the tibia itself is extremely rare, while detachment of the upper fibular epiphysis alone is unrecorded.

According to Roberts and Kelly (1916), only 26 cases of diastasis of the upper end of the tibia have been recorded. Cases were reported by Heuston and Manly in 1888. In 1895 the subject was discussed by Jonathan Hutchinson, Jr. He stated that he had notes of ten cases. Poland referred to 24 cases. Tanton, in 1916, recorded a case which occurred in a boy of twelve, who was knocked down by an automobile, a wheel of which passed over the upper part of the left leg. The fibula was not broken, but the upper epiphysis of the tibia, perched on the arête formed by the anterior border of the upper end of the diaphysis, was split into two unequal pieces.

Reduction was brought about by traction under anæsthesia followed by fixation in plaster-of-Paris in the position of flexion.

The patient was seen six months afterwards and the result was " perfect."

Age.—Hutchinson's youngest patient was twelve months. His oldest sixteen years. Poland's cases ranged from three to twenty years.

Cause.—The usual history is of a violent wrench to the leg accompanied by abduction or adduction producing a transverse strain. In Poland's opinion, direct pressure against the epiphysis is the chief factor. In a case recorded by Fischer and Hirschfeld " a severe machinery accident caused separation of the upper tibial epiphysis and detachment of both fibular epiphyses." Hutchinson refers to specimens in St. George's and the London Hospital museums. In one of these the foot was run over and the leg bent forcibly inwards.

The upper epiphysis of the tibia owes its comparative immunity from detachment partly to its small size, as compared with the lower femoral epiphysis, but mainly to the fact that it is surrounded by very strong ligamentous and periosteal guards. The tibial collateral ligament of the knee-joint, the ligamentum patellæ, and the semi-membranosus not only gain attachment to the epiphysis itself, but all three structures send off strong prolongations to the neighboring periosteum and deep fascia. On the medial side, the line of junction of epiphysis and shaft is strengthened by the tendons of sartorius, gracilis, and semi-tendinosus. On the lateral side the head of the fibula forms a direct buttress to the epiphysis and the fibular collateral ligament forms a flying buttress. Also worthy of note is that from the first movement of leg on thigh, the upper tibial epiphysis is accustomed to strains with a transverse component whereas the lower femoral epiphysis is habituated mainly to direct thrusts.

FIG. 1.—Condition on admission.

In view of the severity of the violence producing the lesion, it is rather strange that the diastasis is seldom compound.

Clinical Features.—The displacement is usually incomplete and frequently very slight. In direction it is usually forwards, forwards and outwards, or forwards and inwards. In several cases extensive fracture of the diaphysis is recorded. In all but one of Poland's cases, the separated epiphysis carried with it the tongue-shaped process forming the upper part of the tibial tubercle. There is usually considerable swelling of the tissues in the neighborhood owing to effused blood. The knee-joint itself is generally full of fluid. At first sight the injury suggests a posterior dislocation of the knee-joint. This is ruled out by the age of the patient, by exact interpretation of bony points, and finally by the X-ray.

Prognosis.—This is on the whole rather less reassuring than one would suppose. In 12 of the cases mentioned by Poland the patient died or the limb was amputated. Probably in many cases the original violence is so great that the patient suffers severely from shock or from accompanying more serious injuries. Septic infection, however, seems to play an important rôle in the progress of the case. One of Hutchinson's cases developed suppuration on the sixth day after the accident, with " emphysema and pus, followed by death," probably an anaërobic infection. The case narrated by Fischer and Hirschfeld developed suppuration six weeks after the injury. Amputation was performed. The tearing of soft parts, the outpouring of blood, and the devitalization of the skin, form ideal ground for bacterial development. The

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pressure of splints, however light, may be enough to tip the balance in the direction of necrosis, especially if the adjustment of parts be not absolutely accurate. While this unfortunate denouement is not infrequent, it is not the rule. According to Poland, " in several of the cases which recovered, no trace remained of the injury."

Does shortening of the limb ever occur? According to Kirmisson, " notwithstanding the contrary results of experimental research, shortening of the injured limb has been rarely noted in actual practice . . . It is necessary to take into consideration compensatory elongation of the neighboring epiphyses." The older the patient, the more nearly full growth has been attained,

FIG. 2.—Condition on discharge.

the less the influence of stoppage of growth at an epiphysis. Further, the upper tibial epiphysis is only one, and not the most important, of the growing nodes of the lower limb. Again, a separated epiphysis may mean cessation of growth but does not necessarily do so. On the whole, therefore, provided reposition be exact, the prognosis regarding growth is good.

One example of premature arrest of growth is recorded by Volkmann. " A boy aged three had been knocked about by a drunken father. At the age of four he began to limp. After this no more growth occurred at the upper end of the tibia. The shortening which resulted was 3 inches. The femur of that side, the foot, and indeed the whole lower limb partook to a less extent in the lack of development." (Quoted from Hutchinson.)

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The following case came under the notice of the writer lately. Because of the rarity of the condition it seems worth recording. P. M., male, aged fourteen years, was referred by Dr. W. Tucker, Francis, Sask. July 10, 1922, the boy got his left lower limb caught in the wheel of a plough. The skin was not broken.

July 19, 1922, examination showed marked swelling and discoloration about the left knee. The appearance suggested a backward dislocation of the tibia on the femur. Swelling was so great that it was impossible to distinguish accurately the bony prominences around the knee. There was marked laxity in all directions, and pronounced ecchymosis in the popliteal space. There was no swelling of the leg; no interference with circulation in the toes, no evidence of a nerve lesion. X-rays showed a diastasis of the upper epiphysis of the tibia with a fracture of the upper end of the fibula, a short distance below its epiphysis. The tibial epiphysis was displaced forwards and slightly laterally in relation to the shaft. The tongue-shaped process corresponding to the tibial tubercle remained attached to the epiphysis, thus obscuring the abruptness of the backward displacement. The upper tibial epiphysis maintained its normal relation to the lower end of the femur.

July 20 a curved incision was made on the medial side of the knee, and tissues were dissected through until the bone was reached. A large quantity of blood clot was removed from the wound. There appeared to be a good deal of pulping of the muscles posteriorly. It was found to be comparatively easy to replace the bone in its normal position, but exceedingly difficult to maintain it there. The epiphysis itself was tilted forwards and the best apposition was obtained with the knee flexed about 30°. A cuff of plaster was applied over the dressings to include the calf and the lower half of the thigh. Traction ropes were incorporated in the plaster, at the level of the upper part of the calf. By means of the traction ropes the limb was slung from a cradle, the axis of the pull being almost in the line of the thigh.

August 5, plaster was removed, stitches were taken out, the leg cautiously straightened and an X-ray taken. The X-ray showed good position antero-posteriorly, but there was still a trace of lateral displacement, producing in the fully extended position a slight degree of genu valgum. Fresh plaster was applied with the knee fully extended. This reached from the toes to the groin, and a clinical correction of the genu valgum was made. This plaster was worn until September 19, a window being cut for the dressing of a skin slough, about one inch in width and three inches long, adjoining the line of the incision.

After removal of the second plaster another radiograph was taken. Clinically and radiographically, the result promises to be entirely satisfactory. (Fig. 2.)

Comment.—The necessity for partial flexion of the knee was very strikingly manifested while the wound was open. It was possible to gauge with accuracy the degree of flexion necessary to maintain apposition and the direction in which traction could be best applied to maintain the optimum position. It is a truism that the best anatomical reposition is likely to give the best functional result. While treatment on a McIntyre splint might have given an equally good result, it could hardly have been carried out with the same degree of confidence in the result. The removal of the blood clot was also a distinct advantage. In the case of the fractured fibula, union appears to be satisfactory.

REFERENCES

Fischer and Hirschfeld: Berlin klin. Wchnsch., 1865, p. 93.

Hutchinson: Brit. Med. Jour., 31st, March, 1894.

Keen: Surgery, vol. ii, p. 260.

Kirmisson: Rev. d'orthop, 2s. vol. v, pp. 523-552.

Poland: Traumatic Separation of the Epiphyses.

Roberts and Kelly: Fractures, 1916.

Stimson: Fractures.

Tanton: Bull. et Mém. Soc. de Chir. de Paris, 1916, vol. xlii, pp. 27-30

SPONDYLOLISTHESIS

By S. Kleinberg, M.D.

of New York, N. Y.

In reporting another case of forward subluxation of the last lumbar vertebra, I desire to emphasize three points: (1) The condition occurs more frequently in males than we have heretofore believed; (2) the lesion presents a radiographic appearance which is pathognomonic and has not been found or described in any other lesion, and (3) trauma is frequently the direct cause, or at least, a very important factor in its etiology.

Anatomy of the Lumbo-sacral Region.—The lumbar vertebræ are placed one below the other, with the fifth lumbar situated in a wide interval between the fourth lumbar and the sacrum. The bodies of the lumbar vertebræ are large, the transverse diameter longer than the vertical, and in a flat photographic impression they appear quadrilateral. The sacrum is tilted forward on a transverse axis so that its superior surface faces upward and forward. The fifth lumbar, lying upon the sacrum, is also tilted forward, though to a less degree, so that its superior surface is directed upward and forward. The forward inclination of the fifth lumbar has been assumed to be a weak point in its relationship with the sacrum. In a lateral view one gets the impression that the fifth lumbar is ready to slip forward off the sacrum, and that it is restrained only by the ligamentous attachments. The lumbar articular processes, placed in the sagittal plane, favor a dislocation.

The X-ray Appearance of the Normal Lumbo-sacral Region.—The radiographic appearance of the lumbo-sacral region varies according to the location of the X-ray tube in relation to the last lumbar vertebra. If the tube is directly over the lumbar vertebræ so that its central rays pass through the lumbo-sacral junction, the lumbar vertebræ appear, in an antero-posterior view, as quadrilateral shadows. (Fig. 1.) The last lumbar is distinctly visible and is larger than, or at least as large as, the other vertebræ. The intervertebral spaces above and below the last lumbar measure at least a quarter of an inch in the vertical direction. Laterally the intervertebral spaces are bridged across by the articular processes. The main feature which I wish to direct attention to in this picture is that each lumbar vertebra is distinctly outlined and the fifth lumbar is separated from the sacrum by an appreciable interval. At about the middle of each vertebra is a small shadow differentiated from the surrounding bone by its greater density; this is the spinous process. The sacrum is approximately triangular, with its base directed upward; there are curved transverse lines in its shadow representing the transverse ridges between the various sacral segments.

If a lateral view is taken with the tube over the lumbo-sacral region, the bodies of the lumbar vertebræ appear as a series of square blocks, their

anterior and posterior surfaces forming somewhat curved but continuous lines. The anterior part of the intervertebral space between the last lumbar and sacrum is wider than the posterior part, but the lines of the anterior and the posterior surfaces of the lumbar vertebræ are continued to the corre-

Fig. 1.—Appearance of the fifth lumbar vertebra when the central rays of the X-ray tube pass through the lumbo-sacral region. The intervertebral space between the last lumbar and the sacrum is visible and limited laterally by the articular process. The fifth lumbar, like the other lumbar vertebræ, is quadrilateral. Its spinous process is represented by a dense shadow in the middle of the body: a, spinous process; b, transverse process; c, articular process; d, intervertebral space between the fifth lumbar and the sacrum; e, transverse sacral ridges.

sponding parts of the sacrum. The fifth lumbar vertebra is well above and quite distinct from the sacrum.

If the tube is opposite the dorsal vertebræ, the appearance in the lateral view is the same as that just described, except that the shadow of the sacrum is usually hazy and the outlines of the sacrum are often indistinguishable.

The antero-posterior view (Fig. 2) shows a totally different picture from that described above. All the lumbar vertebræ except the last appear rectangular. The area occupied by the fifth is diminished. In this space one sees two oblong masses joining medially at an obtuse angle, and forming the
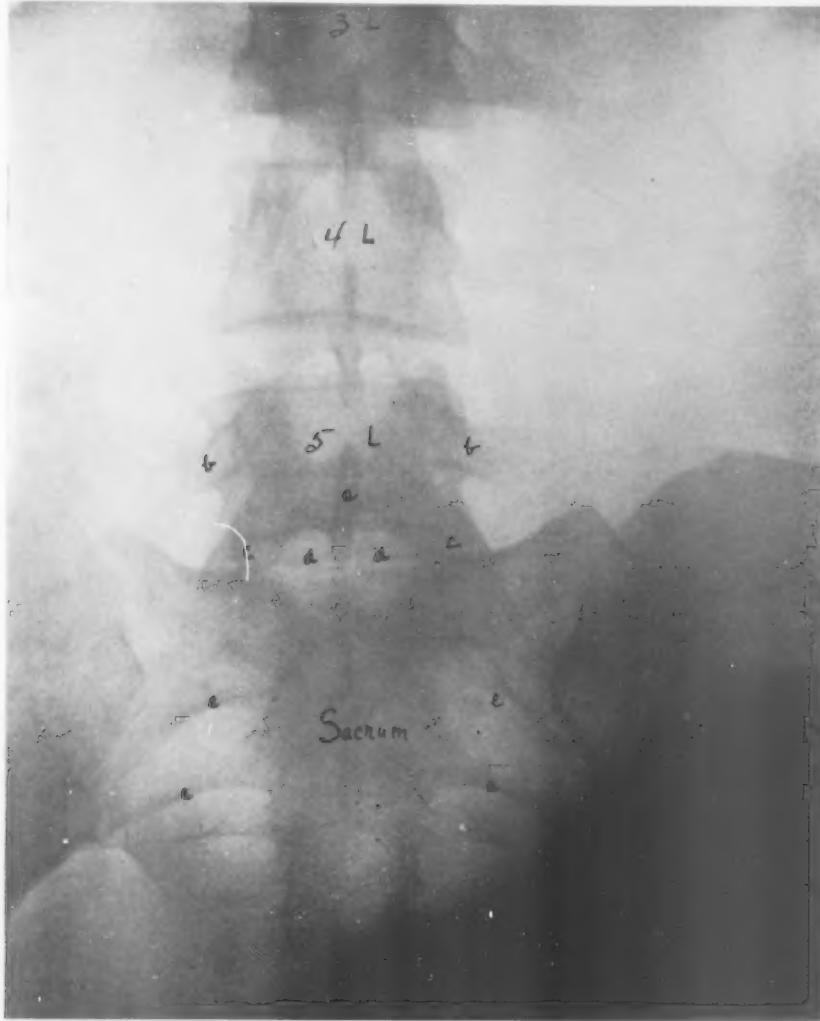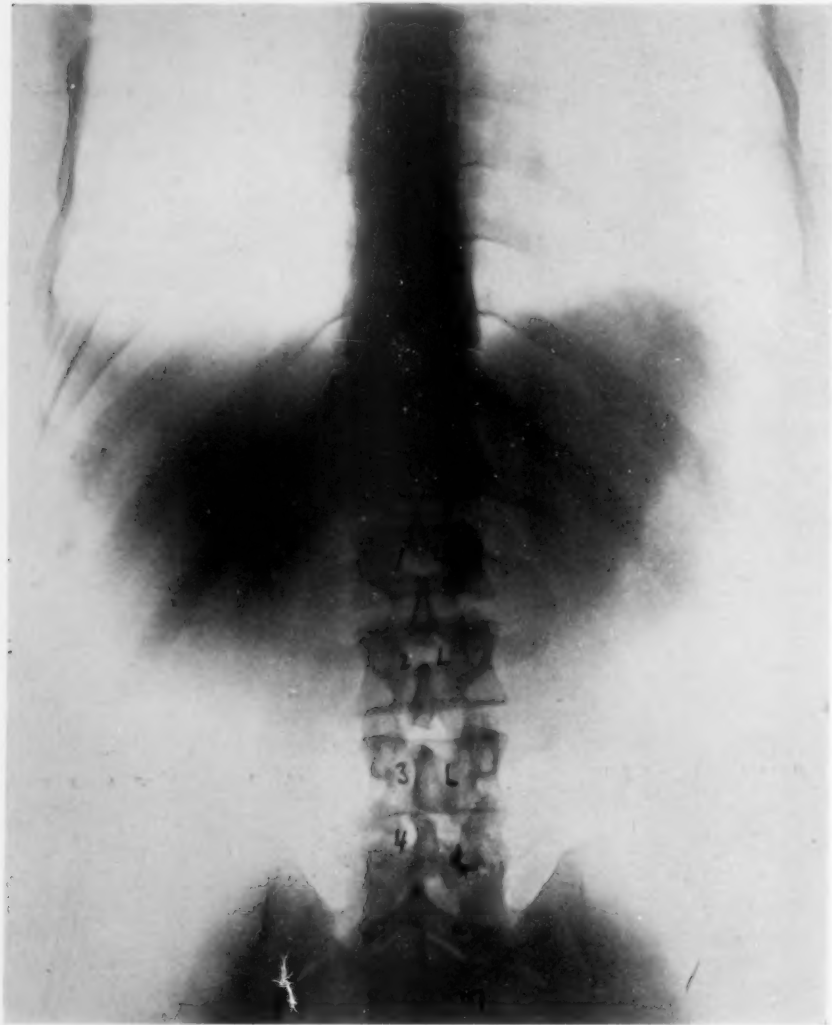

Fig. 2.—Appearance of the fifth lumbar vertebra when the central rays of the X-ray tube pass through the dorsal region. All that we see of the fifth lumbar is its posterior arch. Note the laminæ, a, and the spinous process, b. The body of the fifth lumbar is not seen nor is the intervertebral space between the body of the fifth and the sacrum visible. When the tube is held lower down a part of the body of the fifth lumbar is brought into view. The radiogram of the fifth lumbar vertebra presents many variations between the extreme view shown in this picture and that shown in figure 1, dependent upon the location of the X-ray tube.

posterior arch of the fifth lumbar vertebra. Above this is a faint transverse linear shadow of the upper border of the body of the fifth lumbar; the transverse processes are very close to and often appear to overlap the iliac crests. The inferior surface of the body of the fifth lumbar and the intervertebral space between this bone and the sacrum are not visible. The upper

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part of the sacrum is seen directly below the posterior arch of the fifth lumbar. The body of the sacrum appears smaller than normally because of fore-shortening of its shadow. This appearance of the last lumbar and the sacrum is due to the fact that the rays strike the lumbo-sacral region obliquely and pass through both the last lumbar and the sacrum.

X-ray Appearance in Spondylolisthesis.—When the last lumbar becomes dislocated anteriorly, it moves downward and forward so that the body of this vertebra overlaps and lies in front of the upper sacral segments and its upper surface faces distinctly forward. The result is that in a front view of the patient, we are looking at the superior surface of the last lumbar vertebra and at the anterior surfaces of the sacrum and the other lumbar vertebræ. The shadow of the last lumbar will then show the body, transverse processes, laminæ, spinous process and spinal foramen. The body of the last lumbar vertebra will overlap the upper part of the sacrum and its spinous process will lie unusually close to the fourth lumbar vertebra. The other lumbar vertebræ will appear as rectangular masses and the sacrum triangular as usual. Therefore, when in an X-ray picture of the lumbo-sacral region we see an appearance as described above, namely one in which the entire outline of the superior surface of the last lumbar vertebra is seen, while the other lumbar vertebræ appear quadrilateral, then a diagnosis of forward dislocation of the last lumbar vertebra is justifiable. Of course in a clear lateral view the presence of the shadow of the body of the last lumbar in front of, instead of above the sacrum, makes the diagnosis absolutely positive. But as it is difficult and maybe impossible in a very large or obese individual to attain a good lateral view, while it is practically always possible to obtain a clear antero-posterior view, the appearance in the latter position is of prime importance.

Etiology.—The text-books, especially those on obstetrics, have taught us to believe that this condition is almost always found in women, and is due to a congenital defective development of the lumbo-sacral region, and to marked stretching of the ligamentous structures incidental to pregnancy and parturition. Study of the accident cases, and especially more extensive and expert use of the X-ray machine, show that spondylolisthesis occurs comparatively often in men. Of eight cases that I have seen in the last few years, one was in a girl, and the others in adult males. In all of the males there was a distinct history of trauma preceding immediately or by some weeks or months, the onset of symptoms. This raises the question of the etiological relationship between trauma and the dislocation. It has been argued by some that such a severe lesion as spondylolisthesis could hardly be the result of the degree of trauma which is usually mentioned in the history. In my own three patients the condition followed a direct blow on the back, as in a fall, in two cases, and a sudden strain resulting from an unexpected load being thrown on the shoulders in the other. In all the cases reported by Doctor Darling from the orthopædic services in the Hospital for Ruptured and Crippled, there was a history of injury direct or indirect at some time prior to the onset of symptoms. There is no doubt in my mind that there

probably is some developmental defect in the lumbo-sacral region affecting the body and more particularly the ligamentous structures in all these cases. I believe, however, that trauma is the chief factor in the etiology of this type of dislocation, granting that the individual may be anatomically predis-
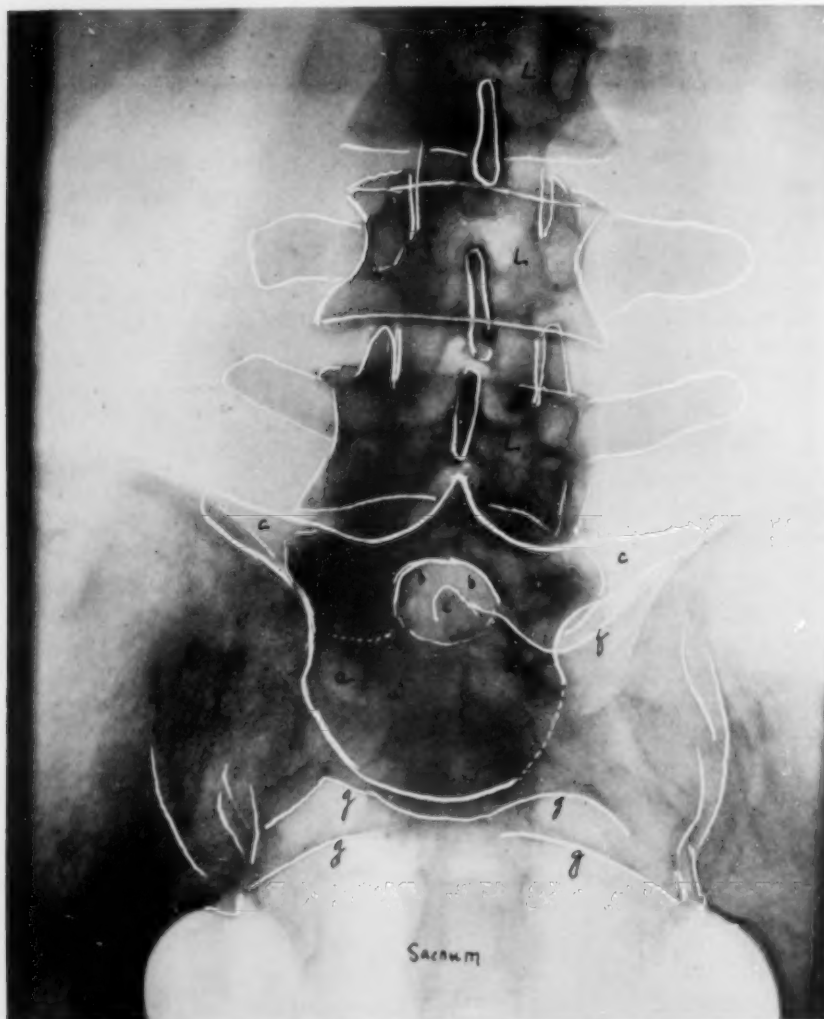
FIG. 3.—Spondylolisthesis. The fifth lumbar vertebra is seen below the fourth lumbar and in front of the upper sacral segments. In the shadow of the fifth lumbar are seen the markings of its superior surface, namely: a, the body; b, the neural foramen; c, the transverse processes and d, the spinous process. The other lumbar vertebræ appear rectangular. e, Spinous process of the first sacral segment; f, upper border of the sacrum; g, transverse sacral ridges.

posed to such a lesion. In a previously reported case,* the patient, a very intelligent man, was sure that before the injury and onset of symptoms he did not have the hollow above the sacrum which was visible and palpable at the time of my examination. The case to be described had no symptoms referable to his back up to the time of his accident, although for many years he

* Kleinberg, S.: Archives of Surgery, July, 1921, vol. iii, pp. 102–115.

had continued at laborious work. When a lesion and disability follow an injury, it is proper to attribute to the injury a large measure of responsibility for the lesion. And while I am willing to concede that the injury described in these cases would not or might not cause a dislocation in a so-called normal spine, yet it must undoubtedly be responsible for the sudden appearance of the lesion in a susceptible individual.

Case Report.—J. C. Male, age sixty years, was injured January 19, 1922. He fell from the seventh story of a building on which he was working. There is no history as to how he landed on the ground. He was taken to a hospital where a diagnosis of fracture of some ribs and rupture of the urethra was made. He was confined to bed for about three months. During this time he had pain in the back, but this was not very distressing and little attention was given to it by the patient. When he began to walk about, he found that the backache persisted and was aggravated by all motions of his body. The pain was in the lower part of his back and radiated down both thighs.

Examination showed that he walked without assistance and without a limp. The back was symmetrical and the spine in the median line. There was a shallow groove above the sacrum, evident but not marked. There was persistent tenderness at the lumbo-sacral junction. All the motions of the spine were restricted and painful.

The X-ray picture, Fig. 3, shows the typical findings. The outlines of the vertebræ and sacrum were intentionally emphasized by me in the plate sent for a copy so that the lesion might be easily seen. The second, third and fourth lumbar vertebræ appear rectangular, the transverse processes are seen projecting laterally on either side and the spinous processes are in about the middle of each vertebra. The fifth lumbar vertebra is seen lying in front of the upper part of the sacrum and its upper surface is distinctly outlined. Instead of the vertebra appearing rectangular as do the others, there is a crescentic outline of the body of the vertebra; the transverse processes lie unusually close to the lateral masses of the sacrum and the iliac bones; the posterior arch is very distinct and the spinous process is above its normal position and very near to or perhaps in direct contact with the fourth lumbar. In the middle of the spinal foramen of the fifth lumbar is seen a shadow which is undoubtedly that of the spinous process of the 1st sacral segment.

The chief points of interest in this case are a history of an injury, persistent pain in the lower part of the back, tenderness over the lumbo-sacral region, a hollow above the sacrum, limitation of motions of the spine and a characteristic X-ray appearance.

The occurrence of another case of spondylolisthesis in a male serves to direct our attention to the apparently greater frequency of this lesion among men, particularly laborers, than we have heretofore believed. There can be little doubt that in this patient as in the other two reported by me, trauma played a very important rôle in the causation of the dislocation. As the diagnosis can be made positively only from the X-ray findings, and particularly in view of the fact that the physical signs in most cases simply spell an injury of the back, without any guide to a more accurate diagnosis, this case demonstrates the importance and necessity of careful and competent radiography in all lesions of the back.

† Osgood, Robert B., Journal of Industrial Hygiene, July, 1919, vol. i, No. 3, pp. 150–57.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held November 22, 1922

The President, Dr. John A. Hartwell, in the Chair

TUBERCULOSIS OF CHEST WALL

Dr. Hugh Auchincloss presented a man sixty-two years of age who at twenty-five, thirty-seven years ago, suffered a Neisser infection. No history of lues. At thirty-five, twenty-nine years ago, pneumonia, but a certificate made out by his doctor for insurance benefit was signed "phthisis." At fifty-eight, in 1918 had influenza with bad cough for three months. Controlled after three weeks' treatment. Six months ago had a temporary recurrence of cough. Three months ago soreness developed in left side, and two months ago noticed a small lump over region of fifth rib in anterior axillary line. Examination showed a thin, wiry man of 124 pounds, who looks as if he had lost weight. There are sub-crepitant râles at both apices and in first interspace on left side. There are occasional râles at both bases. Breath sounds, voice, fremitus and resonance are not very markedly changed. In anterior axillary line over fifth rib is a fluctuating, slightly tender swelling, not attached to skin, not pulsating and fixed on chest wall. X-ray shows an irregular mottled area of shadow suggestive of calcification of pleura, red blood cells 4,200,000, hæmoglobin 80 per cent., leucocytes 8200, polymorphonuclears 75 per cent. Blood urea, uric acid and sugar are normal. Urine is quite negative. Blood Wassermann: Chol. ++++, Alc. ++++. Several examinations for tubercle bacilli in sputum have been negative. Aspiration of abscess: Grayish, caseous-appearing material containing much cellular debris. No organisms seen.

Operation.—October 29, 1921. Local anæsthesia. Abscess excised and about 12 cm. of 4th and 5th ribs removed with intercostal muscles. The upper margin of the 5th rib was slightly concave as though there had been some decalcification, but this seemed a small lesion compared to that on either side of it. The pleura had been changed to a firm sheet of smooth, calcified, possibly ossified material that could be tapped on with an instrument, producing a resonant tympanitic sound, due to the subjacent lung. A sinus from the abscess cavity only about 0.5 cm. in diameter led to the surface of this sheet of calcium at the level of the 5th rib and was attached to a very small punctate depression that would not admit the end of a probe. The wound was closed after smearing in a small amount of iodoform and splitting the pectoralis major so as to draw it across the sheet of calcium, suturing it to the serratus magnus. Tubercle bacilli were found in the pus from the abscess. Discharged nineteen days after operation. Diagnoses: Tuberculous abscess of lat-

eral costal region; chronic pulmonary tuberculosis, quiescent; syphilis. Wound entirely healed, good scar. December 5th, one month. Letter received stating sinus with watery discharge had appeared. Gained six pounds. February 21, 1922, four months. Very small sinus—working, March 21st, five months. Still a tiny sinus that crusts over. April 29th, six months. Treated with bismuth paste in Boston. " Definite improvement is apparent." October 27, 1922, twelve months. Been treated in Massachusetts General Hospital, Out Patient Department most of summer. Sinus did not heal but it was kept clean and in good condition. November 4, 1922, twelve months after first operation, under local anæsthesia, the sinus was excised, the old incision reopened, the tissues pushed away from the plate of calcium and the calcium removed with the exception of a small amount well posteriorly. It lay over the lower part of the lung, the diaphragm and the outer portion of the pericardium, all of which structures were separated from it by sharp and blunt dissection. Slightly thickened pleura beneath it was opened in one place and normal looking blue lung visualized. The lung did not collapse to any great extent. No tubercular tissue was evident. The wound was sutured but a thin discharge occurred with small sinus formation. This has improved, the sinus being smaller and the discharge lessening, and, inasmuch as well nourished soft parts are now in contact one with another, it is probable that it will close. The sinus and calcium deposits are apparent in the specimen.

This patient was shown before this Society October 26, 1921, in connection with a paper on Tuberculous Abscesses of the Chest Wall (ANNALS OF SURGERY, Vol. lxxv, April, 1922, p. 416) as Case IX. He demonstrated what large amounts of calcium may be deposited in such cases and how the foreign body calcium placques may interfere with healing. This is also a follow-up interval result on a case which when shown a year ago had not then been operated on.

DR. ALLEN O. WHIPPLE considered that this case comprised a distinct group differing from other cases of tuberculosis of the chest wall in that the ribs are not involved. In studying this group of cases, it would seem to be primarily a tuberculous lesion of the pleura and not of the ribs. A great many of these cases seen late show a secondary infection, but if seen early they have no sinus and afford an opportunity for complete removal of the tuberculous tissue, and when closed without drainage heal by primary union.

SUPPURATIVE ARTHRITIS AND OSTEOMYELITIS

A second case, presented by Dr. Hugh Auchincloss, was a boy, twelve years old, who on April 9, 1919, struck inner side of left knee. Had had occasional sore throats in the past. His knee became increasingly painful, and on admission to hospital he was slightly cyanosed and dusky, pulse was rapid, tongue coated, and he appeared septic. Right tonsil was large and red, left tonsil smaller and also red, crypts not filled with exudate. No cardiac murmurs. Left lower first molar carious. The region of the left knee was swollen, slight bluish, red tinge over inner

aspect of lower end of femur associated with marked tenderness with its maximum point at the upper part of the condyle. There were all the signs of fluid in the knee-joint with moderate tenderness. The leucocyte count, 14,000, 83 per cent. polymorphonuclears, the day before had risen slightly to 17,400, 84 per cent. The X-ray showed the slightest rarefaction above the inner condyle of the left femur just above and close to the epiphyseal line. (Fig. 1.) Blood cultures taken before and after operation were both positive for hæmolytic staphylococcus aureus. Temperature 103.4°, pulse 130, respirations 28.

Operation.—April 15, 1919, six days after onset of symptoms. Aspiration of knee-joint of 30 c.c. turbid purulent fluid, containing hæmolytic staphylococcus aureus, was done. An incision along inner condyle was made, and after cutting through the musculo-aponeurotic layer, a few drops of brownish thin pus was found coming from the depths, as from bone. A cavity containing not over 2 c.c. of pus and softened cancellous bone was found above the upper part of the internal condyle. No further extension could be found and the wound was packed with iodoform gauze and a catheter to allow of introduction of Dakin's solution. Culture of pus from bone abscess cavity showed hæmolytic staphylococcus aureus. Six blood cultures taken in eleven days were positive for hæmolytic staphylococcus aureus. The knee-joint was aspirated of purulent fluid containing staphylococcus aureus on culture six times in nineteen days, washed with saline five times and saline preceded by 1 per cent. carbolic three times. Twenty-five days after the first operation an abscess cavity containing about 50 c.c. of pus was opened beneath the extensor muscles immediately in front of the bone. The wall of the inner bursa of the joint could be seen perfectly and no communication found. His temperature became practically normal on the 30th day and he was discharged July 16, 1919, after thirteen weeks in hospital. But very little active motion was possible with this boy until about the fifth week, during much of this time slight traction was maintained.

He reported to the out patient department after having been fitted with a knee brace that allowed him to walk and run about and even kick a football. However, a persistent sinus remained, and it was not until March, 1920, that he was readmitted to the hospital. A small incision was made over the sinus and a sequestrum removed, whereupon the wound firmly closed within the next few weeks. There is a moderate varus deformity due to the effect of the lesion on the ossification zone above the epiphysis, otherwise there is a useful knee with complete flexion and extension.

This case is presented because he demonstrates a severe suppurative arthritis of the knee-joint associated with bacteriæmia and a small bone focus, seen early in the course of the disease, that had had his knee-joint aspirated but not drained. It is perhaps wisest for attention to be paid more to the lesion in the tissues immediately outside a joint rather than to the joint fluid. In dealing with an early case such as this, adequate and immediate drainage of the focus outside the joint is the essential feature. Aspiration of the joint, even though
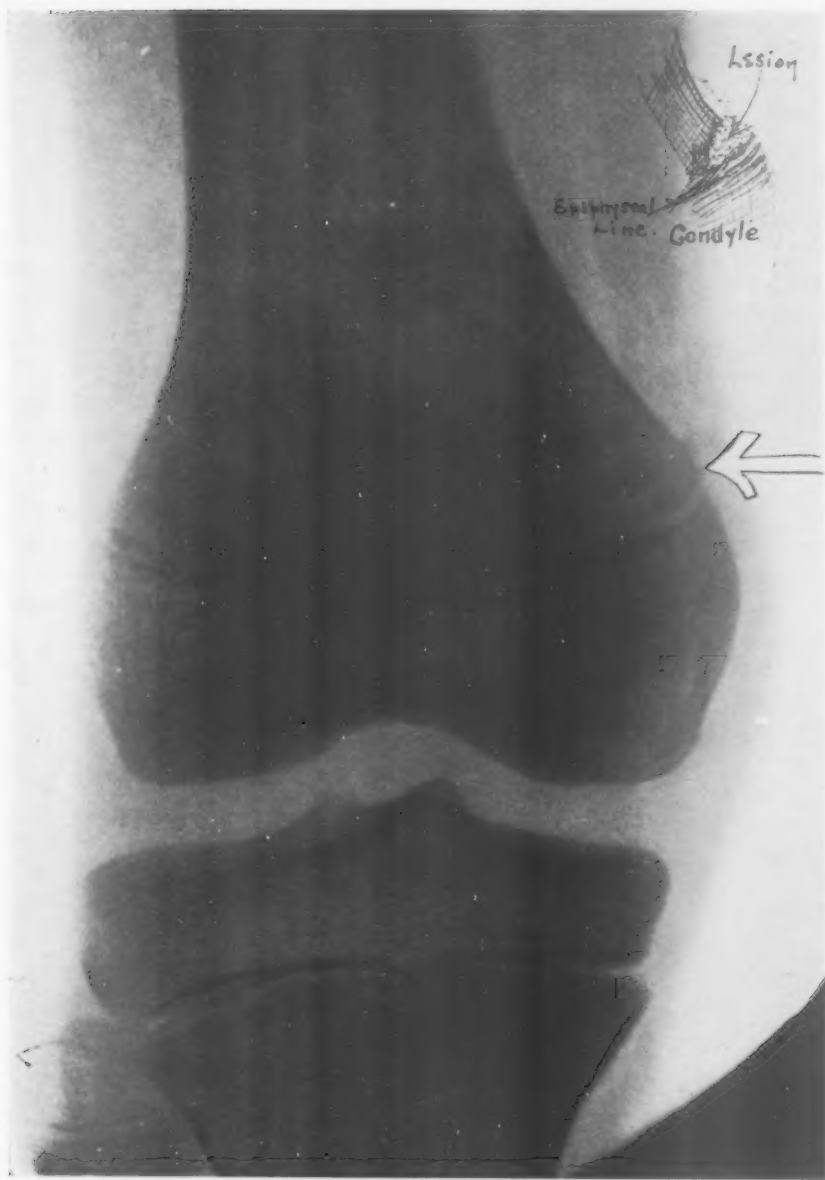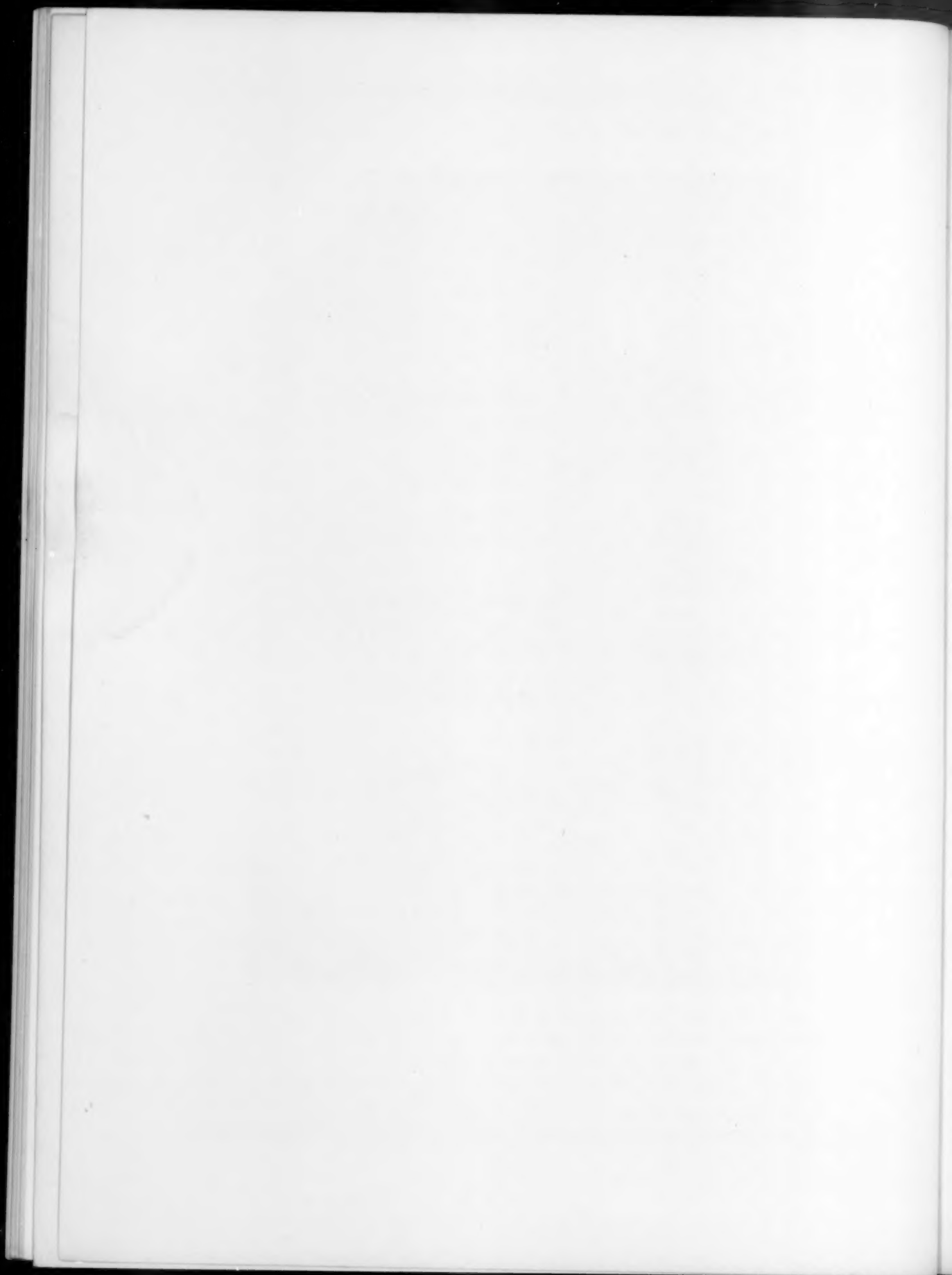
FIG. 1.—Case A. R. Shows site of bone lesion as shown five days after onset. Slight rarefaction and uneven periosteum above the ossification zone, separating the diaphysis from the epiphysis.

it has to be repeated was done successfully in this case and has been done successfully in others and is probably a good procedure. Drainage of such a joint is probably unnecessary. The process has not gone far enough and the time has been short for necrosis to any extent to have occurred in the actual lining of the joint. Where necrosis of the actual lining of the joint has occurred to any marked degree, drainage is probably better than aspiration. In later cases or in cases that have become infected through trauma or gunshot injury with presence of foreign body for any length of time, the joint lining is seriously damaged, and in these cases free drainage is probably always indicated. By drainage is meant adequate opening of the joint cavity, but placing of no drainage into the joint cavity, and taking such measures, of which active motion is the most desirable, to insure the passage of exudate from within the cavity out, in as free a manner as possible. Whether the joint is aspirated or drained, the principle of active motion is of course most important in securing early and complete function, and it should be encouraged in every possible way, even though the patient refuses to coöperate. But whether the joint cavity be drained or aspirated the main feature is the adequate treatment of the focus immediately outside the cavity.

Dr. Clarence A. McWilliams thought it would be wiser to open a septic knee at once in view of the bacteriæmia. After aspiration there is no external drainage, consequently there must be absorption of organisms into the general circulation which, in a severe case, might turn the tide against the patient. Doubtless Doctor Auchincloss took the type of the organism into consideration in persisting in aspiration. Had it been streptococcus he probably would have opened it at once. This case seemed to the speaker to have lax ligaments which possibly might be explained by the repeated distentions of the joint. In addition, opening the joint would have allowed active motions to be instituted at once.

Dr. Royal Whitman considered that the lax ligaments might be explained by the incongruity of the articular surfaces with consequent outward deviation when weight was borne. This might be corrected by osteotomy, but as there was apparently no functional disability this seemed hardly indicated at present.

Doctor Auchincloss in closing replied that osteotomy had been considered, but the problem was whether to do it now or later on after he had attained his growth. It had been thought wiser to wait and then see if it would be necessary.

TRANSPLANTATION OF TENDON

The following case presented by Dr. Hugh Auchincloss was a girl, six years old, who when four years old, April, 1920, cut hand with glass at base of left middle finger. She could apparently move her finger normally at the time. The wound was dressed and nothing much thought of it. Two days later her brother came down with diphtheria. On the third day she was given an immunizing dose of diphtheria antitoxin, and that night her temperature was 103°. There was considerable question as to whether this was due to

the hand or the antitoxin. On the fourth day the hand was incised by the physician in charge and a surgeon was called on the fifth day. He incised the proximal phalanx at once, and on the eighth day the middle phalanx. Three weeks later another incision was made to examine the tendon. After two months all the wounds were healed. Four months later she was seen by Doctor Blake in consultation, who thought that if the tendon had been cut it might be possible to do a tenorrhaphy after freeing the distal portion were it found adherent. The family physician informed me, however, that the tendon had

FIG. 1.—Showing the deformity.

FIG. 2.—Showing extent and character of scar, before tendon transplantation.

been exposed in the wound, that he was sure it had not been cut at the time of injury, that a true suppurative tenosynovitis had occurred, and that the tendon had not sloughed out.

When first seen, four months later, in October, 1920, there was free motion at the metacarpo-phalangeal joint. The finger was straight. (Fig. 1.) There was no active motion whatever in the interphalangeal joints though they could be freely moved passively. A scar extended from the distal flexion crease of the finger to the middle flexion crease of the palm. It was slightly to the ulnar side of the midline. (Fig. 2.) The problem was, accordingly, one not infre-

quently seen, of adherent flexor tendons to the digital sheath. In making a fist the proximal phalanges were in alignment, but the middle and distal phalanges of the middle finger stuck out in full extension. It was decided that it might be wise to let more time elapse between the closure of the wounds and any plastic attempt, so that the operation was performed January 3, 1921, about seven months after the wounds had closed, and nearly twenty-three months ago, with the patient's family fully aware that I considered the chances of success exceedingly small.

Under ether anæsthesia, with a tourniquet about upper arm, incision was made along the side of the finger to the web and thence into the palm and deepened to sheath, sparing the digital vessels. The flexor tendons were adherent and the profundus particularly so in its course over the middle phalanx. The vaginal ligament with its function of a phalangeal annular ligament, over the proximal phalanx was gone. It was just possible to make out dense bands corresponding to the vaginal ligament of the middle phalanx and these were preserved. Old scar tissue fibres were all that corresponded to the transverse metacarpal ligament in the palm. Both flexor profundus and sublimis tendons were then removed from the distal interphalangeal joint well into the palm of the hand, by a careful dissection, endeavoring to preserve every strand that might be of use to serve as a vaginal ligament. This was done by sharp dissection and with tendon strippers as recommended by Doctor Bunnell. An incision over the extensor longus digitorum of the left fourth toe was then made and about seven centimetres of the tendon was removed, not only in its sheath but also with the deep fascia covering the sheath that was incised for about one centimetre on either side of the tendon. The lateral flaps thus made were sutured together on the under, or plantar, surface of the sheath. The tendon readily moved up and down within a synovial sheath and entirely surrounded by fascia. Fine Stiles' linen thread was laced into the ends of the tendon and the tendon then attached to the base of the terminal phalanx in the finger by means of the stub of the removed profundus tendon that had been split to receive it. Before doing this a specially constructed silver tube with obturator was passed beneath the remains of the vaginal ligament over the middle phalanx and the obturator withdrawn. Traction sutures were placed in the fascial-synovial investments on either side of the end of the tendon where the suture had already been laced in, and all three sutures were then passed through the canula and the tendon with its synovial and fascial sheaths drawn through and the canula removed, thus avoiding trauma to the tendon and its investments. The proximal end was united to the combined ends of the flexor tendons by lacing the ends with Stiles' linen thread after Bunnell's technic and the fascial and synovial investments drawn down as far as possible so as to cover the anastomosis. A slip from the neighboring extensor brevis was united to the distal cut end of the extensor longus tendon to the toe and both wounds sutured with extra fine silkworm gut. The finger was put up in flexion. Though it took over three hours there was very little reaction and the wound healed promptly with narrow scar. Motion was

begun on second day. Only the slightest range at first, but as soon as wound healing had been pretty well established, the range was increased. It was extremely disappointing, however, to find that she had no definite motion in the interphalangeal joints.

The main problem was then to provide a way for the child to call the muscle cells of the two tendons to that finger into voluntary action. Electricity, massage, vibration, v a r i o u s occupations were considered, but finally it was decided to make the attempt in the following manner: By means of an elastic band stretched from adhesive plaster stuck about the tip of the finger to a wristlet (Fig. 3), the finger was held in flexion by elastic traction. By extending her finger against this elastic traction, an act she could readily do, she was compelled to contract the muscle cells of the two tendons that had been sewn to the transplant. It is simple for anyone to demonstrate to himself that when finger extension is carried out under resistance that the flexors contract as well. Such an apparatus was worn during the day and removed at night through the most persevering coöperation
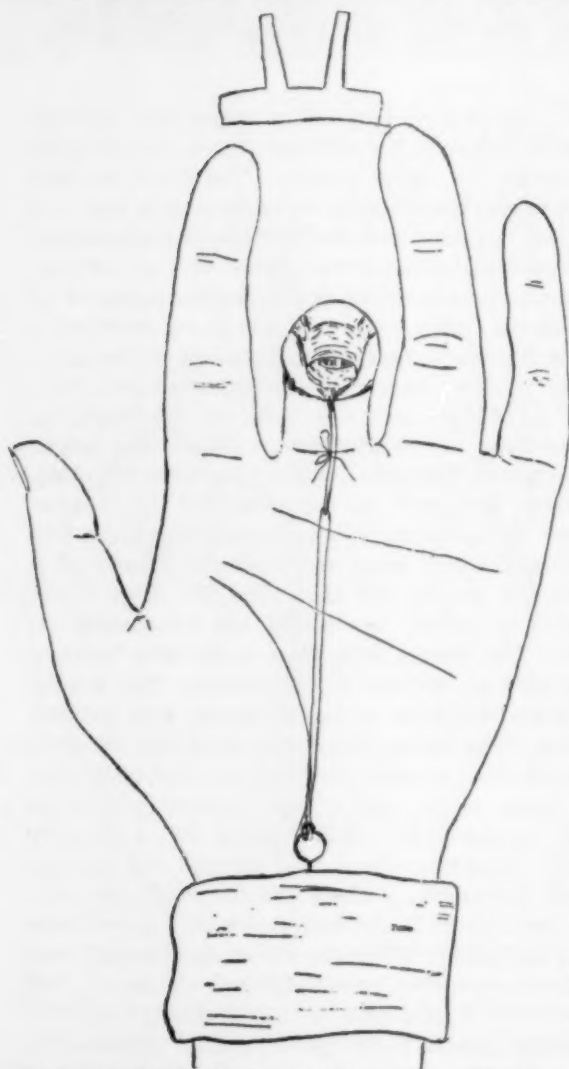
Fig. 3.—Showing application of elastic traction apparatus.

of the child's aunt who was caring for her. For three months no real motion could be made out. At three and a half months, slight definite motion was observed in the proximal interphalangeal joint. By four and a half months, it had increased. In February, 1922, it was apparent that she was moving the distal interphalangeal joint and she had begun piano lessons. It was thought the transplant was slightly longer

than it should have been, that a period of taking up slack had been gone through and that if now function to any extent had been gained that with the years of growth combined with function ahead of her it is possible this finger may eventually compare favorably with the rest.

She now has almost complete flexion in the proximal interphalangeal joint though there is but little, if any, in the distal interphalangeal joint. It was thought that the principle of elastic traction was of great value in this case.

Dr. SEWARD ERDMAN asked Doctor Auchincloss how he explained the complete inability to flex the distal phalanx; and whether or not this lack of flexion might be due to adhesions in the successfully transplanted tendon, which might be released by a further operation.

In reply, Doctor Auchincloss said that he rather thought that the reason was due to the technical difficulties in making an attachment of the transplanted tendon in its sheath to the short stub of profundus tendon attached to the base of the phalanx. This had to be done practically over the joint and the small area in which to work, because of the size of the finger at four years of age, left little leeway for a refined anastomosis of any sort.

BLOOD TRANSFUSION

Dr. EDWARD W. PETERSON read a paper with the above title, for which see ANNALS OF SURGERY, vol. lxxvii, page 364.

Dr. RICHARD LEWISOHN expressed his accord with Doctor Peterson as to the value and limitations of blood transfusion. He was not, however, in accord with Doctor Peterson in his estimate of the value of the different methods, and he felt he should not let pass unchallenged Doctor Peterson's claim as to the superiority of uncitrated blood over citrated blood. There is plenty of proof that the immediate and late effects following the citrate method are as good as those following transfusion of uncitrated blood. Claims of biologic superiority of uncitrated blood are based on a recent publication of Unger. Unger's first contention was that citrated plasma has anticomplementary power. His second contention was that sodium citrate increased the fragility of the red blood cells and therefore citrated blood could not be used in hemorrhagic diseases. He further contended that the phagocytic index of the leucocytes is decreased by sodium citrate. Mellon, Hastings and Casey have stated that their results were diametrically opposed to those of Unger. According to these authors citrated plasma has no anticomplementary power, and red blood cells and leucocytes are not affected by sodium citrate.

Referring to the question of chills following transfusion, Doctor Lewisohn said that it is usually claimed that the sodium citrate is followed by many more chills than all the other methods. At Mt. Sinai Hospital, from January to November, 1922, thirty-four citrate transfusions were followed by eight chills, and twenty-nine Unger transfusions by ten chills, making twenty-three per cent. of chills for the citrated method and thirty per cent. of chills for Unger's method.

Dr. Charles G. Heyd considered that too much was expected from blood transfusion. When it was properly indicated it was an ideal procedure. In cases of acute sepsis it was not indicated and the surgeon was under the necessity of combating a strong prejudice in the minds of the relatives of the patient as to the value of blood transfusion in these conditions. In a number of cases of acute sepsis the speaker had found blood transfusion of no value as a curative agent and only slightly so from the partial stimulation it gave. There is a very large financial and social aspect in the prevalent idea that blood transfusion should be used in all cases of acute sepsis. It only entails expense to the family and does not in any appreciable way benefit the condition. At the present time transfusion is independent of technic and of operator. It is such a common practice in all general hospitals and the procedure so simple that the senior internes can be expected to do it. Doctor Heyd congratulated Doctor Peterson upon his carefully determined indications for blood transfusion. A special point of danger should be emphasized in that it is possible to activate hemorrhage by massive transfusion, and that the time of transfusion is equally important with the amount of blood to be transfused. Another point of importance is that certain donors have a higher degree of coagulability than others. In cholemic states a transfusion before operation is better than two or three afterward. As to the merits of citrate and whole blood transfusion, they both have their places. The latter would, however, seem to represent the ideal transfusion. There is a wide feeling for both kinds of blood transfusion, and emphasis should be placed upon the indications for transfusion and the optimum time for giving it rather than upon the technic of method.

Doctor Peterson, in closing the discussion, said that in spite of the rather well understood indications for blood transfusion, the operation was done many times when it could do no possible good. It was frequently suggested, in hopeless cases, after other measures had failed, in the hope that it might be of benefit. A procedure which lends itself so readily to commercial exploitation is apt to come in for a certain amount of abuse. As to the methods of whole blood and citrated blood the speaker, not being a serologist, had to rely on his own clinical results for his impressions and conclusions. He had used citrated blood in about 100 instances and had returned to unmodified blood transfusions because, in his own experience at least, there seemed to be no doubt as to the superiority of the latter. Bernheim, who had charge of the transfusion work in the A.E.F., had recommended citrate transfusion without qualification, in his book, but since then has modified his views and makes the following significant comments:

" We must not be blind to the fact that the sodium citrate blood transfusion possesses certain obscure but none the less inherent features that are not only embarrassing to the physician but most uncomfortable and even dangerous to the patient. Chills and fever and profound shock have never helped anyone, and to ignore the danger of these sequelæ, merely to note their occurrence

without vouchsafing a careful consideration of their eventualities, is little more than admitting a mind closed to certain embarrassing features connected with the procedure."

I would not have you think for one moment that this is an attempt to belittle the value of the citrate ransfusion. No one realizes better than I how much that has meant to the medical profession and to humanity at large. But it is necessary to recognize the fact that there are definite limitations to this method of giving blood, and that failure to observe these limitations has caused unnecessary loss of life.

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CORRESPONDENCE

TRACTION APPARATUS FOR OPEN REDUCTION
OF FRACTURES

EDITOR ANNALS OF SURGERY:

Sir:

THE open reduction of any fracture is justly regarded a hazardous procedure to be undertaken only after attempts at closed reduction have failed. In spite of the advances made in the treatment of fractures, there remains a certain although diminishing number of fractures which require operation. In the operative treatment of these, certain principles have been well established, *i.e.*, the necessity of the most rigid aseptic technic, of avoiding all trauma to the tissues in the reduction of the fracture, and of preventing so far as possible the introduction of fingers and instruments into the wound.

FIG. 1.—Appearance of traction apparatus described.

In this clinic open reduction has most often been necessary in spiral fractures of the tibia. In some of these we have had great difficulty in bringing the two fragments into apposition even with the use of Lowman clamps, Lane tongs and a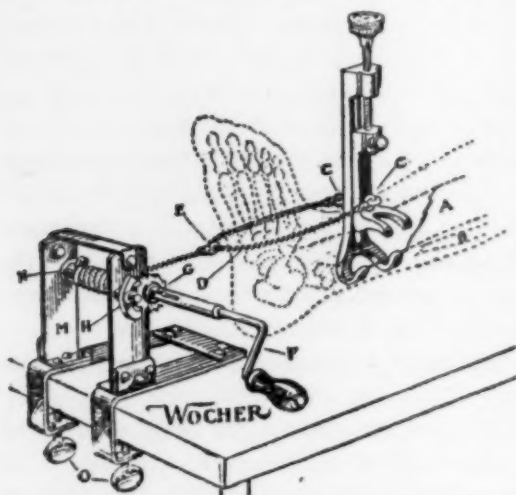 Lane skid; and, often, after the fragments have been brought into apposition, with what we believed a considerable amount of trauma to the tissues, we have found it difficult to plate or place a Parham band because of interference by the instruments required to hold the fragments in place.

For the twofold purpose of avoiding as far as possible all trauma to the tissues and of eliminating from the wound all instruments which might interfere in the fixation of the fracture, the instrument here presented was devised. It combines great traction power with the ability to hold the fragments in apposition.

The windlass " M " (Fig. 1) is made of steel and is 3.5 inches high and 2.5 inches broad, so that it can be readily sterilized. It is composed of the uprights and reënforcing bands as shown in the illustration. The steel cylinder " N " revolves by turning the handle " F." The ratchet " G " and

brake " H " prevent the cylinder from unwinding after traction has been obtained. In the cylinder " N " is an open-eyed screw into which one end of the wire cable can be hooked. The other end of the cable is hooked to the cable " E " which encircles the foot, the two ends of which are hooked into the open-eyed screws " C " of the Lowman clamp. These two open-eyed screws " C " are placed on the *movable* part of the clamp at points opposite each other. The line of traction therefore is always parallel to the shaft of the bone, no matter what the size of the bone, and the two screws are always exactly opposite each other.

In regard to the method of procedure, the accompanying drawing is self-explanatory. The operating table is slightly inclined with the head down, in order that the patient will not be moved when traction is applied. This is obviously quite important. The bone is then isolated well above and below the line of fracture and the clamp applied to the lower fragment, and screwed down tightly. The windlass is then clamped to the end of the table, the cables applied as in the illustration, and by turning the handle " F " the fractured ends are pulled into approximation. They are held in this position by the brake on the windlass until a bone plate or band, as the case demands, is applied. The traction is then released gradually, the clamp removed, and the wound closed in the usual manner.

With this technic, trauma to the tissues, which is unavoidable when reduction is attempted by placing tongs and using a skid, is largely eliminated.

An added advantage of technical importance is that while the upper fragment is fixed, the lower fragment can be easily rotated at the same time that the desired amount of traction is maintained. This is not true when a turn-buckle is used, because both clamps rotate together, often necessitating the readjustment of the clamps before the desired amount of rotation of the lower fragment is obtained.

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CHARLES Y. BIDGOOD, M.D.,
BURR N. CARTER, M.D.,
Cincinnati General Hospital,
Cincinnati, Ohio.

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BOOK REVIEWS

BRAIN ABSCESS. ITS SURGICAL PATHOLOGY AND OPERATIVE TECHNIC. By
WELLS P. EAGLETON, M.D. MacMillan Company, 1922.

The author states his belief that a positive diagnosis of brain abscess
should be possible; further, that it is possible to ascertain its location in a
large proportion of cases; and also that from the history obtained, especially
in relation to the time of existence and date of the chill, or even the first
vague chilliness, it is possible to determine whether the abscess is encapsulated.
A thorough history is vital. It may shed light on the date of the first "vague
chill" which has become almost axiomatically the sign of the time when
infection passes the barrier of the dura and reaches the piaarachnoid; a matter
of extreme importance as suggesting the length of time the abscess has
existed; for revealing attacks of uncontrollable vertigo, suggestive as to
locating the abscess or tumor in the cerebellum; for determining the previous
presence of periods of a "dreamy state"; of previous or present aphasia,
temporary or long-continued; complete motor, sensory or "naming" ataxia;
gradual or sudden hemiplegia; of appreciable intervals between the loss of
power in hand, leg and face; or an unrecognized hemianopsia. Some or all
of these always occur during the development of brain abscess.

Hemorrhage is one of the serious drawbacks to the comfort of the brain
surgeon, and to the control of this much space is devoted through various
sections of the book. Hemorrhage is less troublesome in brain abscess than
in brain tumors where the increased intracranial pressure produces excessive
general oozing. The author follows Cushing in the method of dividing the
vessels of the dura, closing them with silver wire "clips" as he proceeds, the
aim being to rigidly prevent the exudation of blood into the piaarachnoid.

The author regards the "stalk" of a brain abscess as always a late
manifestation. It is nature's effort to evacuate an encapsulated abscess
through the original site of the infection. Favoring this theory are the
numerous cases recorded of the spontaneous evacuation of pus through the
extension of a stalk to, and a secondary necrosis of, the dura, followed by
cure of the abscess.

The author recognizes that in chronic intracerebral abscess of the tem-
poral lobe secondary to infection of the brain through the tegmen typmani,
more recoveries occur by an operation following the track by way of the
mastoid antrum, than by cutting through the uninfected dura over the exter-
nal surface of the temporo-sphenoidal lobe; because in the first case the area
of protective adhesions already built up by nature can be utilized and its
track followed to the abscess cavity.

The mechanical difficulties of draining abscesses of the brain are com-
pared to those of effort to withdraw the entire yolk of an egg and still leave

the surrounding white with the least possible disturbance of the latter. The interior of the brain is a semisolid mass of nerve cells and glial tissue and only held in shape by the surrounding piaarachnoid envelope, lacking muscular structure which, by contracting, aids the expulsion of abscess contents in other parts of the body. Hence the author makes the following axiomatic observations: The nearer the pus approaches the density of the surrounding cerebral tissue, the greater the difficulty of complete evacuation. The firmer the envelope, the greater the possibility of entrance into the abscess cavity of an instrument which can insure drainage, cleansing and obliteration of the cavity. Pus of thin consistency can be more completely evacuated than thicker pus.

The author lays stress on the importance of complete evacuation of a chronic adjacent intracerebral abscess of the middle fossa at the first operation. It is the only chance of success, or, in the words of the author, " the surgeon, in chronic brain abscess with a capsule, has but one major chance to combat infection, namely, *at the time of the primary operation.*" He quotes two clinical observations in support of this statement as follows: " If following an operation for brain abscess the disappearance of the symptoms is *accompanied by almost complete cessation of the discharge,* complete primary evacuation-relapse and refilling of the abscess cavity but rarely occurs; secondly, on the other hand, continuation after the first few days of a profuse discharge from the drainage tube—incomplete primary evacuation—frequently results in recurrence of the symptoms, associated with a sudden cessation of the discharge; cleansing of the tube showing that the cessation of the discharge is not due to plugging of the tube, but that a new area of encephalitis is present which is unconnected altogether with the region previously drained."

The author does not condemn puncture of the dura for evacuation of a brain abscess, in that it gives a large proportion of recoveries. Nevertheless, it has the disadvantage that subtemporal or piaarachnoid abscesses will either be entirely overlooked or imperfectly evacuated. In abscess with a capsule the puncture method will fail. It is recommended, however, in acute brain abscess, provided it results in evacuation of the fluid and the establishment of a " tract."

" A brain abscess with a capsule, if near the cortical surface, should be thoroughly evacuated, its walls inspected and cleansed, and its cavity obliterated, so that on withdrawal of the inspecting encephaloscope, the surgeon should *know* that no recess of the abscess has been overlooked." The author believes that " second " abscesses are always prolongations of the main abscess and united to it. On the evacuation of the pus from the main abscess an obliteration of the entrance to the " second " is usually produced through collapse of the surrounding tissue. The author uses an illuminated headlight and his own modification of the Whiting encephaloscope by which the interior of the abscess is thoroughly examined. The drain is preferably of rubber

tissue. Subsequently to the operation, further drainage of pus is accomplished with a soft rubber catheter (graduated) which must be securely anchored to the margin of the wound. Gravity may be utilized to assist drainage by lowering the head of or changing the position of the table.

After operations on the brain, all purulent material having been evacuated, every surface except the portion which conveys the drainage should be entirely covered. To place dry gauze over an exposed area of piaarachnoid is to invite disaster. The rubber drainage tube or rubber tissue used for a drain is led through dura, bone and skin to the nearest external surface and anchored; the remaining surface is recovered with dura, or if protruding brain tissue prevents, an edge of fascia lata, which most nearly substitutes a dural surface. The wound is best left undisturbed for as long as possible, a few days at least, so that protective granulations may have covered the disturbed piaarachnoid surface before the first dressing. The other recommends that the drain be allowed to become slowly expelled, rather than to repeatedly remove and reintroduce it. As it protrudes, the outer part is cut off and again anchored to the edge of the wound until no further drainage is necessary.

The author defines "adjacent abscess" as one which has occurred by direct invasion of the brain by direct extension, by processes of tissue suppuration, thrombophlebitis or perivasculitis, as, for example, from the mastoid antrum, the middle ear, labyrinth or nose, to either one of which it is directly connected by the pathological process. Metastatic abscess is of hæmatogenous origin, having been conveyed from heart, lungs, ear or elsewhere by the blood stream. Metastatic abscess of the brain follows the occlusion of a cerebral vessel by an infected nidus circulating freely within the blood stream; bacterial invasion of the blood stream alone apparently being insufficient to produce brain abscess. This type of brain abscess is sudden in its onset, with violent headache, dizziness and projectile vomiting, apoplectiform, though perhaps transient.

The great majority of cerebellar abscesses originate from aural infections. The author makes the following surgical classification of cerebellar abscesses. Those situated in or on the anterior surface of the cerebellum; in all of which infection has gained access to the brain through the posterior surface of the petrous pyramid of the temporal bone; and (2) cerebellar abscesses in or on the posterior two-thirds of the lateral hemisphere of the cerebellum, in which infection gains access from the lateral sinus. He plans operation on the following bases: (1) to evacuate the abscess at its nearest approach to the dura; (2) so as to reduce the intracranial pressure, and (3) to prevent excessive cerebral herniation.

One of the surprising things recorded by the author is the large number of cerebral abscesses in which are combined labyrinthitis and sinus infections. Most important in cerebellar abscess is the determination of the seat of the original infection. Hence the extreme importance of investigating the state of the labyrinthine function. The presence of a dead labyrinth, indicated

by non-reaction of the labyrinthine function, is strongly suggestive of the abscess being located in the cerebellar fossa.

The author discusses most interestingly the causes and mode of operation on abscess of the frontal lobe; gives a chapter devoted to hernia cerebri; another to protective mechanism of the brain; others to the diagnosis of brain abscesses in general; to diagnosis of adjacent temporo-sphenoidal abscesses, diagnosis of cerebellar abscess and to complications and results. In three appendices he treats of " Guide for Detailed Neurological Examination," " Analysis of 125 Cases of Cerebellar Abscesses " and " Analysis of 140 Cases of Ruptured Frontal Lobe Abscesses."

The writer of this review would extend to the author his sincere congratulations on the successful completion of this work. It will be read and referred to by surgeons and students as an indispensable source of information on surgery of the brain for a long time to come.

WILLIAM C. BRAISLIN.

ARTIFICIAL LIMBS AND AMPUTATION STUMPS. By E. MUIRHEAD LITTLE, F.R.S.C., Eng. Philadelphia, P. Blakiston's Son & Co., 1922.

The question of efficient protheses for the maimed has become of great moment to the world at large during the past few years. Until the present publication was received there had been no attempt to inform not only orthopædists, but the profession generally what points were necessary to consider in drawing a specification for an artificial limb. The subject has been to all practical purposes completely neglected in our modern systems of surgery, and only that phase considered which instructed the surgeon how to obtain the best type of stump.

The Germans even two years ago had published an encyclopædic work on the subject of artificial limbs, and the author's present work hardly covers such an extensive compilation of facts, even the French antedated this present volume by a handbook on artificial limbs written by Broca and Ducroquet. There has yet to be published any authoritative American work covering the subject. The physician or surgeon usually turns over the patient to a company making such limbs, and either not having any subsequent supervision of the patient or, until having this work to consult, not even knowing what could be accomplished or how best to accomplish it.

The subject is presented most rationally and the author has succeeded in not making the book a compilation of limb-makers' catalogues, although he has used their illustrations freely where it best suited his purpose, employing some two hundred and sixty-seven. The text is lucid, readable and definite, representing the author's experience in the treatment and supervision of twenty-five thousand cases of amputation which have come under his notice chiefly at the Roehampton Hospital.

The question of amputation stumps is thoroughly considered and is followed by a chapter on cineplastic and other procedures for improving their utility. He calls attention to the fact that in arm protheses, the design and

details of manufacture present the greatest difficulties, and are more important than the fitting of the socket to the stump, while in leg protheses the converse obtains.

The chapters on arm and leg protheses are well illustrated, working drawings of the intricacies of these artificial members being shown, as well as many and various appliances which may be attached to them to improve their usefulness.

Reference to various types of limbs necessitated is rendered easy by referring to the Ministerial list of numbers on page 195, which form a series corresponding to sites of amputation of the leg from above downward which are most frequently used, while a similar tabulation is made on page 122 for those protheses necessary for amputated arms.

The Ministry of Pensions advocates the employment of an alloy of aluminum known as "duralumin" for use in arm protheses in general, as it appears to have given the best results after exhaustive tests, while the leg sockets are constructed of a material known as "certalmid," a combination of glue, muslin and celluloid, although the wooden socket allows of the nicer adjustment but weighs a little more.

In an appendix one finds a more detailed specification for artificial limbs and directions for making "certalmid" sockets and for fitting the Ministry's light metal leg.

The amount of labor and observation necessitated in the compilation of this volume can not help but be remarked, certainly such a correlation of ideas is greatly needed. To those interested in this type of work, the present edition will prove of the greatest value and it is to be highly recommended, containing as it does the present summation of the observations of one most competent to elucidate a complicated but very pertinent subject.

JAMES T. PILCHER.